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## OSSEOUS METASTASES FROM GRADED CANCERS OF THE BREAST

WITH PARTICULAR REFERENCE TO ROENTGEN TREATMENT

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OF ALL the metastatic malignant lesions in bone, those occurring secondary to cancer of the breast are the most common. In a review by Sutherland, Decker and Cilley,<sup>61</sup> of the Mayo Clinic, of 1,032 cases in which there was roentgenological evidence of metastasis to bone, 393 (38 per cent) were traced to a primary source in the breast. This figure is roughly similar to the 30 per cent figure of Copeland<sup>44</sup> reporting on 334 cases of osseous metastasis studied at Johns Hopkins Hospital and to the more recent 36 per cent incidence of Fort<sup>20</sup> at Stanford University Hospital and San Francisco County Hospital based on 112 such cases in which positive roentgen diagnosis of skeletal metastases had been made. The frequency with which metastasis to bone occurs from cancer of the breast has been difficult to determine. Necropsy studies by various observers have shown the incidence of such metastasis to vary between 20.5 and 73 per cent. Notable among these reports are those of: Gross<sup>29</sup> reporting 20.5 per cent incidence in 425 autopsied cases with breast cancer; Handley<sup>30</sup> finding an incidence of 22 per cent in 329 necropsies at the Middlesex Hospital from 1872 to 1891; William<sup>66</sup> in 1908 reporting a figure of 26.5 per cent based on 893 such postmortems reported in the literature; Risley,<sup>58</sup>

25 per cent; Kaufmann,<sup>40</sup> 53.3 per cent in 63 autopsied cases; and Ginsburg<sup>24,25</sup> reporting 75 per cent incidence of bone metastases in a series of such cases carefully examined postmortem at the Montefiore Hospital. Osseous metastasis from cancer of the breast is a terminal event, and is one manifestation of the generalized extension of the disease throughout the body. Therefore, its incidence should approach 100 per cent in those patients in whom cancer of the breast is the primary cause of death. One cannot help feeling that the percentage-incidence of bone metastasis from the breast varies with the thoroughness with which the patients are examined for bone lesions, and that the higher percentages reported more nearly approach the true frequency.

Though frequently emphasized by recent writers, the fact that cancer of the breast may metastasize to bone early is not yet taken seriously enough in clinical practice. Metastasis may already be present in the spine or pelvis without sign or symptom at the time the primary tumor is first discovered in the breast. On the other hand, it may delay its appearance up to twenty years or more after removal of the primary breast lesion. Both types of occurrence have come within my clinical experience.



Skeletal metastases from cancer of the breast may occur in any location. The most frequently noted locations of osseous metastases from cancer of the breast are the spine and pelvis, according to such observers as Stenstrom and Ericksen,<sup>63</sup> Sutherland *et al.*,<sup>64</sup> Copeland,<sup>13</sup> Fort,<sup>20</sup> Kaufmann,<sup>40</sup> Lee and Herendeen,<sup>43</sup> Lee and Tannenbaum,<sup>44</sup> and many others. With somewhat less frequency metastases occur in the upper femur, ribs, sternum, skull and upper humerus. Rarely are osseous metastases, particularly from the breast, seen below the knee or elbow. Only 3 or 4 such instances are reported by Stenstrom and Ericksen in a study of 115 bone metastases from cancer of the breast.

Why skeletal metastasis from cancer of the breast should occur most frequently in the vertebral and pelvic bones is not known. Indeed, the existence of deposits of malignant breast tumor in the bone marrow had been realized by pathologists and clinicians a considerable time before any definite explanation of the fact was available. The early conception of the formation of deposits of cancer in the bone marrow depended upon a belief in the existence of a "cancerous diathesis" which was capable of manifesting itself in different regions of the body at the same time or successively. Thus, Sanson,<sup>60</sup> in 1834, described a case in which a woman with a scirrhus cancer of the breast of less than one year's duration broke a femur while turning in bed. During the manipulations necessary for reduction of this fracture, the other femur broke. Later, at autopsy, multiple deposits were found throughout the skeleton, and Sanson cited this case as a most complete example "of that which one calls cancerous diathesis." It soon became obvious, as knowledge in pathology increased in the years following, that the explanation of the process of the formation of metastases was to be looked for in the blood or lymph; that the bone deposits represented cancer cells that had traveled from a single primary source to the point found, where they were growing as secondary tumors.

A considerable controversy has grown as to the mechanism by which malignant cells are carried from the primary cancer to the vertebrae and pelvic bones. Lymphatic extension by permeation, lymphatic emboli, and embolic dissemination by way of the blood stream, each has its ardent supporters. Von Recklinghausen<sup>57</sup> was among the first to champion blood stream dissemination of malignant tumor to bone marrow, the so-called embolic theory. His support of this theory was based on his finding that metastases in bones occur within the medullary cavity, and reach the periosteum only by extension from the interior; that when subperiosteal tissue was invaded it was always in the region of the large foramina, which serve as points of egress for large veins; that the individual cancer cells in the marrow lay within definite channels which were arranged in a manner similar to that of the veins present in marrow; that all blood channels in the invaded area had tumor cells; and lastly, that there was no evidence of lymphatic channels in the medullary cavity. Piney<sup>55</sup> likewise concludes that metastatic deposits in bone are due to arterial or capillary embolism, and brings forth as evidence the detection of cancer cells in the vascular channels in the bone marrow. The vascular nature of these channels is demonstrated by the fact that they contain red corpuscles in addition to the epithelial cells. Piney attempted to demonstrate lymph vessels in bone by the injection method so successfully used for studying lymph vessels in other locations, but was unsuccessful. Piney observes that the bones which have red bone marrow, ribs, sternum, vertebrae, innominate, and upper ends of the humerus and femur, are most likely to be the seat of metastases, and states that anatomically and physiologically, in the red marrow bones, the wider stream bed, the slower circulation, and the more complicated course of the vessels are conducive to emboli lodging at these points. The circulation in fatty marrow, on the other hand, he says, is quite normal. Schmidt<sup>62</sup> was able to show that small

thrombi containing cancer cells were present in the capillaries of the lungs, even in cases where there was no evidence of tumor in these organs on ordinary examination. Many of the epithelial cells in such thrombi appeared to be destroyed; but he was able to observe that they might, on occasion, grow through the thrombus material, and in this way pass into the venous side of the pulmonary circulation, and thus reach the systemic circulation. Neal and Robnett<sup>50</sup> report a case supporting the blood borne theory in which they state that "there was a frank absence of permeation of fascial lymphatics near the invaded bone."

Handley contends, from detailed study of many cases, that "bone deposits in breast cancer are usually secondary results of far-extending growth of cancer along the deep fascial lymphatic plexus." By direct retrograde permeation of the lymphatics, the periosteum of the bones is reached. "Since lymphatics and veins always run together, infiltration of the wall of the concomitant vein is a likely event, and subsequent extension in the bone may take place, as Piney has shown, along the blood channels." He states that "Piney has not adduced any evidence that the cancer cells in the first instance reach the bone by the blood stream," and cites the great infrequency of bone deposits distal to the knee and the elbow "though non-cancerous emboli are known to lodge with special frequency in the distal portions of the limbs." Carnett,<sup>10</sup> from similar observations of his own, accepts the lymphatic permeation theory of Handley. Kolodny<sup>41</sup> reports a direct relationship between the bone marrow and the lymphatic system. He injected three to five drops of india ink into the medullary cavity of bone marrow in dogs and killed the dogs one to three weeks later. Examination of the regional lymph nodes showed dye grossly present in twelve to fourteen days, microscopically present in five to seven days. He also found actual lymphatic channels in bone containing the dye. Kolodny concludes that "bone marrow is directly related to the lymphatic

system. It drains its lymph into certain groups of lymph nodes, the regional lymph nodes of the respective bone. . . . Deviations from the normal in the flow of lymph, namely, the aberration of the lymph stream, the retrograde lymph stream, and the reflux lymph flow, can lead to the metastatic spreading through the skeleton of carcinomatous cells transported in the lymph circulation from the primary tumor."

In conclusion, on the basis of the evidence in hand to date, it would seem that metastases to bone can undoubtedly occur by way of either the blood or lymph channels, although the arguments of von Recklinghausen and his supporters appear as yet the more alluring, and suggest that blood embolus is the more usual route.

In 1891 von Recklinghausen described two types of bone metastases: one, diffuse and destructive, which he termed osteomalacia carcinomatosis; and a second type, osteoplastic in character. It is generally accepted that these two types of manifestation exist. In the former the cortex is destroyed, so that fracture may easily occur; in the latter there is new bone production, and the bone may become heavier and even larger. Askanazy<sup>1</sup> believed that metastasis first produces osteoporosis, which is followed by necrosis, and that such necrotic bone acts as a foreign body to produce new bone. Von Recklinghausen noted that the osteoclasts present in osteoporosis were seldom seen in spreading metastatic areas. He felt that softening of the bone and removal of the inorganic salts took place without their presence—that the tumor first destroyed bone and then grew by occupying the space it produced. New bone formation he attributed as due to hyperemia and hemostasis in the region of the tumor, from obstruction of the capillaries by endovascular tumor emboli. Levin<sup>47</sup> did not find hyperemia and felt that some chemical irritant emanating from the cancer cells acted on the bone, stimulating its proliferation. Kaufmann maintained that a metastatic bone deposit is always surrounded by a zone of inflammation, and this caused the

sclerosis. This non-infectious inflammatory reaction accompanying the development of tumor has been emphasized by Ewing<sup>19</sup> and others.<sup>26</sup> Pfahler<sup>53</sup> feels that the resultant sclerosis is an indication of Nature's attempt to isolate the disease. It is observed that this process is enhanced by roentgen therapy, and is called by Geschickter and Copeland<sup>22</sup> fibro-ostosis. Cave<sup>12</sup> recently expressed the opinion that the type of metastasis is dependent on the path of its entrance into bone. When the cells are blood borne he believes that osteolysis results, and when the tumor reaches bone through lymphatic permeation, osteoplasia results. It appeared to Gray<sup>27</sup> that the thing that determined whether the metastases were osteoplastic or osteoclastic was the type of primary breast tumor, and whether it was rapidly malignant or slowly growing. Thiele<sup>65</sup> believed that the more infiltrating, the less sharply defined and the more slowly growing the primary neoplasm and its metastases are, the greater will be the tendency to osteoplastic change. Downs<sup>16</sup> and Downs and Hastings<sup>17,18</sup> have noted somewhat of a parallelism between the degree of desmoplasia in the primary tumor and the appearance of osteoplasia in its metastases. Leddy<sup>42</sup> states that, superficially, there is no relation between the histopathologic character of the tumor and the incidence or type of metastasis.

Bone metastases from cancer of the breast are predominantly of the osteoclastic character. The sclerosing type was noted in only 2 of 100 cases of Geschickter and Copeland.<sup>22</sup> Lenz and Freid<sup>46</sup> report the type of metastasis in breast cancer as osteoclastic in 77 per cent, and in 23 per cent mixed changes of both osteoplastic and osteoclastic character. Carnett and Howell,<sup>11</sup> reporting on 101 cases with bone metastasis from breast cancer, state that all but two were destructive in type, the two exceptions being associated, in addition, with some osteosclerosis. Sutherland, Decker and Cilley, reporting on the roentgen examination of 393 patients with bone metastasis

secondary to cancer of the breast, graded 375 growths as osteoclastic, 5 as mixed osteoclastic and osteoplastic, and 13 as definitely osteoplastic. Levin reports that, microscopically, all cases show both osteoplasia and osteoclasia, with one or the other predominating.

#### SYMPTOMATOLOGY

The presence of cancerous tissue in bones causes, *per se*, no pain. Metastatic lesions may be present and symptomless for months and even years. At the Mayo Clinic are frequently seen extensive multiple bone metastases in individuals with no sign or symptom except the pain coming from one area of involvement. Pain is, however, usually the first warning, clinically, of the presence of bone metastasis, and does not occur until the periosteum or nerve trunks adjacent to bone become involved by the metastasis or the surrounding inflammatory reaction. Pain may be of two types: local pain, originating through pressure on the periosteum or on the sensory nerves that supply it, resembling pains seen in incomplete fractures, frequently associated with tenderness; and neuralgic pain, such as that seen in "sciatica," pain arising from pressure on adjacent nerves, especially at the points of entry into the intervertebral foramina, and radiated over the entire sensory distribution of the nerve involved. Pain may be mild or transitory at the outset, consisting of an occasional catch in the back, or stiffness, but almost always as time goes on, the pain becomes more severe and constant. An outstanding characteristic is the exalted sensibility of the part involved to jarring, jolting movements. In a series of cases reported by Leddy, the pain was severe in 95 per cent of cases, and in nearly half of these it was described as excruciating, agonizing, or crippling, and in itself presented the major clinical problem. Spontaneous remission of pain did not occur in a single case, although such occurrences have been reported in the literature.<sup>19</sup>

Not rarely the first indication of a metastasis is the occurrence of a pathologic fracture, the fracture of a humerus as the individual props herself up in bed, the fracture of a femur while alighting in the usual manner from a car, the compression of one or more vertebrae while lifting a heavy object. A pathologic fracture occurred at some time or other in the course of events in 15 of the 100 cases of cancer of the breast with bone metastases studied by Geschickter and Copeland. Collapse of the vertebrae may produce compression of the cord, which is occasionally associated with paraplegia and vesical disturbances.

Skeletal metastases may exist for months without much anemia or cachexia, without marked weight loss or emaciation. These are usually more terminal events, at which time are also present, as a rule, internal metastases to more vital structures.

#### DIAGNOSIS

Suspicion of the existence of bone metastasis from cancer of the breast is based on the history of or presence of a primary breast lesion and the occurrence of pain, no matter how slight, in any portion of the body, especially in the lower back. Rheumatic pain requiring morphine, particularly, as Ryneerson and Hench<sup>59</sup> have emphasized, should suggest metastases. In such a situation it is wise to consider metastasis as the most likely explanation, and attempt to establish a positive diagnosis with the aid of the roentgen ray. In the great majority of cases, the presence of bone metastasis can be determined by roentgenographic studies. Occasionally, however, as has been our experience as well as that of Lenz and Freid, Geschickter and Copeland, and others, pain may precede positive roentgen evidence by several months. If the roentgenogram of the part is negative, the patient should be kept under observation, and if the pain continues for more than a few days without other very apparent cause, it is best to establish a tentative diagnosis of metastasis and to treat

accordingly with roentgen therapy. Roentgenograms taken at later intervals may reveal positive evidence, though originally they were negative.

If pain, from the dorsal spine, for example, leads to the finding of a metastatic area, taking roentgenograms of the rest of the spine, pelvis, ribs, and less frequently, other bones, may reveal many additional metastatic areas as yet without clinical symptoms.

As has been said before, metastases from cancer of the breast are predominantly of the osteoclastic type. They are characterized in the roentgenogram by sharply demarcated, though irregular, areas of decreased density in the bone, often presenting a diffused honeycombed appearance at times, with almost complete involvement of the bone, without, however, altering the cortical silhouette. Osteoplastic changes are evidenced by an irregular increase in density, a chalky appearance, often bordering on or associated with the areas of destruction, but without cortical or periosteal thickening.

#### PRESENT STUDY

From a review of the literature it can be seen that much has been written and many theories have been expounded regarding the relationships between the primary cancer in the breast and bone metastases subsequent to it. Significant relationships have been implied between such changes as desmoplasia in the primary tumor and osteoplasia in the bone metastases. In series of bone metastases the number secondary to scirrhous carcinoma, adenocarcinoma and medullary carcinoma of the breast have been noted. The bearing that the type of treatment given the primary tumor has on the time of occurrence of bone metastases has been recorded, and the subsequent course of the patient after the occurrence of bone metastases has been discussed.

The present study was initiated as an endeavor to shed more light on some of the relationships existing between the primary

breast cancer and the character and course of the later occurring bone metastases. The principal object was to determine the influence or bearing which the *type* of the primary breast cancer might have upon the time of occurrence of bone metastases and upon the response of the metastases to roentgen therapy. Because of its previously demonstrated value in the prognosis of tumors arising elsewhere, and its similar prognostic import in breast cancer as already so well shown by Harrington,<sup>32,33,34</sup> the Broders<sup>7,8,9</sup> system of grading of malignancy was followed in this investigation. In the grading, according to Broders' method, the microscopist estimates the proportions of the cells that are partially or completely differentiated on the one hand, and those that are more or less undifferentiated, on the other. The results are expressed in numerals from 1 to 4, as follows: A cancer graded 1 is one in which the proportion of differentiated cells range from almost 100 down to 75 per cent, that of the undifferentiated cells from practically 0 to 25 per cent; in a cancer graded 2, the proportion of differentiated cells ranges from 75 down to 50 per cent, that of undifferentiated cells from 25 up to 50 per cent; in cancer graded 3, the proportion of differentiated cells ranges from 50 down to 25 per cent, and that of undifferentiated cells from 50 to 75 per cent; and in a cancer graded 4, the proportion of differentiated cells is from 25 per cent to practically 0, that of the undifferentiated cells from 75 per cent up to 100 per cent. As far as we know, this is the first study of bone metastases from breast cancer in which the primary tumor was graded according to Broders. Because the cancerous bone deposits most frequently occurred in the spine and pelvis, and in order to better draw comparisons between the results of treatment in the different cases, this investigation was limited to those cases in which metastases to the spine or pelvis were present.

Approximately 200 individuals with bone metastases from cancer of the breast were seen and treated in the Section on Roent-

genology at the Mayo Clinic between January, 1925, and January, 1934. Of these 200 cases, only those complete in *all* the following prerequisites were used for this analysis. The requirements held necessary for admittance to this study were six in all, and are as follows:

1. Radical amputation of the breast, performed at the Mayo Clinic;
2. Subsequent microscopic study and grading of the tumor thus removed;
3. Clinical evidence suggestive of metastases to the spine or pelvis;
4. Roentgenographic demonstration and confirmation of the presence of such metastases;
5. Roentgen treatment of the metastatic area or areas in the Section on Roentgen Therapy;
6. Records of the results of the treatments.

Most of the 200 cases were complete in all but one or two of these details. Many had had the breast operation elsewhere, and had no report as to the grade of malignancy found. In some, roentgenographic evidence of metastases was not shown although the clinical evidence and course seldom left any reasonable doubt as to the correctness of the diagnosis. In a few, all facts were known except the results of treatment. Forty-one cases were complete in all respects, and formed the basis for this study. An additional case fulfilled all requirements, but developed a primary cancer in the other breast of a different grade from the first primary lesion.

Of the 41 patients, 23 had cancer of the right breast, and 18 of the left breast. The average age, at the time of operation, for the entire group was 47.6 years, with a range from twenty-nine to sixty-seven years of age. Grouping the patients according to the grade of their malignancy, the average age of each group at the time of operation varied less than a year from the average for the entire series. Age of patients (Table 1) with Grade 2 malignancies, ranged from 40-60; with Grade 3 malignancies, from 35-67; with Grade 4 malig-

nancies, from 29-63 years of age. The wider range of age of Grade 3 and Grade 4 may not be of any significance, inasmuch as most of the cases fall in these grades.

Twenty-two, or 53.6 per cent, of the 41 cases, fall into Broders' Grade 4 classification; 13, or 31.7 per cent, into Grade 3 classification; and 6, or 14.6 per cent, into Grade 2. No case with bone metastases from Grade 1 malignancies was found.

According to Harrington who studied the gradings of 2,879 cases of primary breast cancer at the Mayo Clinic, the frequency with which each grade occurred was as follows: Grade 4 was the designation in 51.3 per cent of the tumors; Grade 3 was the classification into which 33.6 per cent fell; 12.2 per cent were classified as Grade 2, and 2.9 per cent were Grade 1. Comparing his series with our smaller series known to have bone metastases (see Table II), the percentages of each of the grades of the two series runs somewhat analogous. In fact, they are close enough to suggest that the frequency of the occurrence of bone metastases from a particular grade of breast

TABLE I

CLASSIFICATION OF ALL CASES OF BONE METASTASES BY AGE\* ACCORDING TO GRADE OF PRIMARY LESION

Age	Grade 2	Grade 3	Grade 4	Total
39 or less	0	2	6	8
40-55	4	8	9	21
Over 55	2	3	7	12

\* At time of mastectomy.

cancer is roughly proportional to the frequency with which that particular grade of malignancy appears in the breast. In other words, if in 10 cancers of the breast 5 were found to be Grade 4, it would then follow that in 10 cases of breast cancer developing bone metastases 5 would be of Grade 4. In view of the fact that there were no cases of bone metastases from Grade 1 cancers in our series, the question arises whether the above theorizing applies to Grade 1 as well, whether metastases to bone ever occur in

Grade 1 cancer. To answer this point a list was obtained from Dr. Broders of 2,241 Clinic patients with cancer of the breast which had been microscopically graded by him. Of this number, 64 were graded 1. The histories and follow-up reports on these 64 patients were carefully scrutinized, and in 1 of the 64 patients definite evidence of

TABLE II

GRADE IN PERCENTAGE OF TUMORS METASTASIZING TO BONE (PRESENT SERIES OF 41) AND OF TUMORS AS FOUND IN THE BREAST (HARRINGTON'S SERIES)

	Present Series	Harrington's Series
	per cent	per cent
Grade 1	0.	2.9
Grade 2	14.6	12.2
Grade 3	31.7	33.6
Grade 4	53.6	51.3

bone metastases was established. This patient had a radical amputation of the left breast on July 6, 1922, for a Grade 1 adenocarcinoma 1.5 by 2 cm. in size. There was glandular involvement Grade 2 (on the basis of Grade 4) in the left axilla at the time of the operation. In December, 1926, she developed pains and subsequently lameness, in the left lower limb, and in March, 1927, a pathological fracture occurred in the upper third of the left femur. Roentgenograms taken at the Clinic showed marked destruction in the proximal end of the left femur, with pathological fracture through the area of destruction. The patient returned to her home city and was given roentgen therapy there. The pain was reported still present following therapy, but lessened in August, 1927. She died a year later in August, 1928, and her attending physician wrote that there was carcinomatous involvement, at the time of her death, of the left trochanter and the whole right side of the bony pelvis.

Thus it is established that bone metastases may occur from any grade of breast cancer, and the inference suggests itself that the various grades of malignancy metastasize to bone in somewhat the same

relative proportion that they bear to each other as they occur in the breast.

Now the question arises, if bone metastases do result as frequently from Grade 2 and Grade 3 malignancies of the breast as from Grade 4 cancer, do they occur as early?

The average time after operation until definite symptoms of bone metastases appeared in the 41 individuals was 22.9 months (Table III). In the 22 cases with

conclusions: first, in general the lower the grade of malignancy of the primary carcinoma of the breast, the longer the duration of life before metastases to vertebrae or pelvis occur; second, that, specifically, the course of any single case with a graded lesion may vary considerably from that which is the trend of that particular grade as a whole.

This variation in the time of appearance of bone metastases that occurs among in-

TABLE III  
AVERAGE NUMBER OF MONTHS POSTOPERATIVE BEFORE APPEARANCE  
OF EVIDENCE OF METASTASES TO SPINE OR PELVIS\*

	Grade 4	Grade 3	Grade 2	Total
All ages (41)	13.6 (22)	22.9 (13)	56.7 (6)	22.9
Under 48 (22)	8.6 (11)	19.0 (7)	46.7 (4)	18.8
48 or over (19)	18.7 (11)	27.5 (6)	76.5 (2)	27.5
Extremes of Ages				
Under 40 (8)	6.7 (6)	14.5 (2)	none under 40	8.6
60 or over (5)	24.0 (3)	38.0 (1)	88.0 (1)	39.6

\* Number of patients is noted in parenthesis in each case.

Grade 4 tumors, the average corresponding period was 13.6 months, the majority of the group showing definite symptoms within nine months, and 8 of the 22 patients within three months.

In the 13 individuals with Grade 3 carcinomata, symptoms of bone metastases occurred in from seven to forty-seven months postoperatively, with an average time of appearance of 22.9 months for the entire group. The majority showed symptoms in nineteen months or less, but only 3 in less than one year after operation. The average time of appearance of symptoms of bone metastases in patients with Grade 2 cancer was 56.7 months after operation, the individual times for appearance of symptoms in the 6 cases being 27, 28, 47, 65, 85 and 88 months, respectively. In the 1 case of bone metastases from Grade 1 carcinoma of the breast referred to earlier in this paper, it will be recalled that symptoms of metastasis first appeared fifty-four months postoperatively.

The above facts point to the following

dividuals having breast lesions of the same grade may possibly be due to factors outside of the tumor itself, and may have to do with the soil on which the malignant seed is sown rather than on the character of the seed itself. The age of the patient, or the physical condition usually coincident with that age, the condition of tissues or of the circulation, undoubtedly are such factors (see Table III). Thus while the average time of occurrence of symptoms of bone metastases in patients with Grade 4 breast cancer is 13.6 months after operation, they occur on an average of 7.4 months postoperatively in the 11 patients under forty-eight years of age, and on an average of 18.7 months in the 11 patients forty-eight years of age or over. Or more strikingly, the time of occurrence of those patients under forty years of age averaged 6.7 months, while in those over sixty years of age it averaged 24.0 months. Similar age relationships exist among the patients with Grade 3 and Grade 2 cancer. The average time of occurrence of symptoms of bone



metastases in all patients with Grade 3 breast cancer is 22.9 months after operation. In the 7 cases under forty-eight years of age, the average time of occurrence is 19.0 months, in the 6 cases forty-eight years of age or older, it is 27.5 months. In the 2 under forty years of age it is 14.5 months, and in the 1 patient over sixty it was thirty-eight months. In 6 patients with Grade 2 cancer, the average time of occurrence of symptoms of bone metastases is 56.7 months after operation. For the 4 patients

axilla at the time of the radical amputation of the breast. This proves to be a fact. Gross axillary glandular involvement was noted in 20 of the 22 patients with Grade 4 cancer. In 1 patient there was no involvement found, and in the remaining case there was no note regarding either the presence or absence of such involvement. In the 20 individuals with metastases present in the axillary glands, symptoms of bone metastases occurred on the average of 11.6 months postoperative (see Table IV). In the

TABLE IV

AVERAGE NUMBER OF MONTHS POSTOPERATIVE BEFORE APPEARANCE OF EVIDENCE OF BONE METASTASES IN PATIENTS WITH AND WITHOUT AXILLARY GLANDULAR INVOLVEMENT AT OPERATION\*

	Grade 4	Grade 3	Grade 2	Total
Involvement (33)	11.6 (20)	22.4 (10)	34.0 (3)	16.9
No involvement (7)	21.0 (1)	24.6 (3)	79.3 (3)	47.9
No data (1)	48.0 (1)			

\* Number of patients is noted in parenthesis in each instance.

under forty-eight years of age this average time is 46.7 months, and for the 2 patients forty-eight years of age or over it is 76.5 months. There were no patients in this group under forty years of age. The youngest one, aged forty, had symptoms of bone metastases twenty-seven months postoperative. The oldest patient in this group was aged sixty years, and did not show evidence to suggest bone metastases until eighty-eight months after the radical amputation of the carcinomatous breast, the longest interval noted in the entire series of 41 cases.

As has been stressed by Harrington, where primary cancers are of the same grade, the prognosis as to life is poorer in those patients with axillary glandular involvement present at the time of the operation than it is in those in whom no evidence of glandular involvement is found. This would lead one to expect to find, in patients with the same grade of primary breast carcinoma, bone metastases occurring earlier as a rule in those individuals in which there was glandular involvement noted in the

1 patient without glandular involvement of the axilla, symptoms of bone metastases did not appear for 21.0 months. Ten patients with Grade 3 cancer had glandular involvement in the axilla at the time of operation. In these 10 cases the average time of appearance of symptoms of bone metastases was 22.4 months postoperative. The other 3 patients with Grade 3 carcinoma presented no glandular metastases at the time of the operation, and developed symptoms of bone metastases on the average of 24.6 months after mastectomy. Of the 6 patients with Grade 2 cancer, 3 presented glandular metastases at operation and 3 did not. In the former the average time of occurrence of evidence of bone metastases was thirty-four months, in the latter 79.3 months. In the case of those without glandular metastases, the time of appearance of symptoms of bone metastases was sixty-five, eighty-five, and eighty-eight months respectively. In the 3 cases with metastases in the axillary glands, the time of appearance of symptoms of osseous involvement was twenty-seven, twenty-



eight, and forty-seven months postoperative. It has been the policy of the surgeons and pathologists at the Mayo Clinic for a number of years to grade the degree of axillary glandular involvement from I to IV, grade I representing slight, minimal involvement, grade IV, extensive involvement, and grades II and III intermediate degrees of gross glandular metastatic involvement. In the patient with the Grade 2

relation to grade of malignancy. They were multiple in approximately two-thirds of the cases of each group. Metastases were equally as common in the spine as in the pelvis, more common in the lower dorsal and lumbar spine, and in the ilia than in the upper spine or other pelvic bones. The tenth dorsal vertebra was by far the most frequently involved vertebra, regardless of the grade of the primary cancer. Involve-

TABLE V  
DEGREE OF GLANDULAR INVOLVEMENT AT TIME OF OPERATION OF  
THE PATIENTS LATER HAVING BONE METASTASES

Cases	Degree of Involvement				
	Grade IV	Grade III	Grade II	Grade I	None
Grade 4*	13	2	3	2	1
Grade 3	2	2	5	1	3
Grade 2	0	2	0	1	3

\* No data obtained in 1 case.

carcinoma who went forty-seven months after operation before the appearance of symptoms of metastatic bone lesions, the glandular involvement at the time of operation was grade I, or slight. In the other 2 cases with Grade 2 carcinoma, who went twenty-seven and twenty-eight months before indications of bone metastases, the glandular involvement was grade III (see Table v). Of the 10 patients with Grade 3 carcinoma and coincident axillary glandular involvement, the involvement of the axilla was grade IV in 2 instances, grade III in 2 instances, grade II in 5, and grade I in one. In the 20 similar patients with Grade 4 carcinoma the glandular involvement of the axilla was grade IV in 13, grade III in 2, grade II in 3, and grade I in the remaining 2 cases. It would appear that in general, while knowledge of the grade of the breast tumor is of utmost importance in the prognosis regarding occurrence of bone metastases, the degree of metastases evident in the axillary glands at the time of operation is a consideration of some secondary significance.

The location and number of the metastatic bone lesions apparently bear no

ment of this vertebra was noted in 9 instances.

The location of the pain, which was present in all cases prior to radiotherapy, bore a fair relationship to the location of the bone metastases as shown in the roentgenogram. The almost typical story was that of pain in the lower back, present for varying intervals of time, increasing in severity, greatly aggravated by motion, unrelieved by aspirin and similar preparations, and eventually forcing the individual to bed and partial, if not actual, invalidism. Often morphine was required, and this was usually of only transitory value in mitigating pain. Pain near the hips, with radiation into either thigh, was frequently noted. Low dorsal pain, with radiation along one or both costal borders, occurred in several instances. Pain was occasionally intermittent at the start, present when the patient was active and about, and absent when the patient rested, but in a matter of weeks the pain usually became persistent. The onset at times, however, was acute, with sudden severe pain occurring following some trivial action, such as rising from a chair. Of frequent occurrence was pain arising from one

area of involvement, such as root pain referable to the level of a specifically involved dorsal vertebra, with simultaneous roentgenologic demonstration of the presence of many more areas of metastases throughout the spine and pelvis, none of which were producing symptoms. Indeed this was the rule rather than the exception. In 1 case the only pain was dorsal in location, and the roentgenogram of the dorsal spine was negative for metastases, while the pelvis and lower lumbar spine showed multiple metastases. This case is a good illustration of the statement by Sutherland, Decker and Cilley, that "we have seen at necropsy extensive involvement of the bodies of the vertebrae by metastatic carcinoma, without enough alteration in density or structural form to allow of a definite roentgenologic interpretation of metastasis." There was no apparent relationship demonstrable between the location and type of pain present and the grade of the primary carcinoma in the 41 cases.

Diagnosis in these 41 cases was established by following the precepts set down under the discussion of diagnosis earlier in this paper. In 1 case the diagnosis was established by the occurrence of a fractured femur sustained while alighting at the curb from a taxi. Roentgenograms revealed that it was a pathologic fracture, and established the presence of additional metastatic areas in the pelvis.

The great majority of metastases, as revealed by the roentgenogram before roentgen therapy, were predominantly of an osteoclastic nature. In a few (three), there was a fair amount of osteoplasia present along with the destruction. Although roentgenograms following roentgen therapy were available in only a limited number of cases, in 4 individuals (1 patient with Grade 4 primary lesion, 2 patients with Grade 3 primary carcinoma, and 1 patient with Grade 2 carcinoma) there was striking evidence of repair, with the laying down of new bone, following treatment. In several additional cases there was noted a slight increase in the relative amount of osteo-

plasia, but this was not marked. It has been stated<sup>64</sup> that a comparison of the types of metastases in cases of carcinoma of the breast showed the osteoclastic, purely destructive type predominating in carcinomas graded 4, whereas among carcinomas of lower grade of malignancy there is an increased tendency toward the mixed osteoclastic and osteoplastic types. This statement is not borne out by a study of the roentgenograms available in this series of cases. In the roentgenograms of all patients with Grade 2 carcinoma the metastases were obviously osteoclastic. As has been said before, the only pre-treatment roentgenograms showing moderate evidence of osteoplasia mixed with the osteoclasia were in 2 patients with Grade 3 carcinoma and 1 patient with Grade 4 carcinoma. After treatment, evidence of osteoplasia was as apt to be seen in one grade as another. In each case showing striking evidence of repair, the patient was living twenty or more months after the first roentgen treatment.

Convinced of the lack of relationship between the grade of the primary tumor and the roentgen appearance of secondary bone metastases, we chose numerous roentgenograms of bone metastases at random from among the cases of this series, but including roentgenograms of all grades, and we submitted them to one of the members of the Section of Diagnostic Roentgenology at the Mayo Clinic, and later to another member of the same section, and to a member of the Section on Radiotherapy. They were asked to try to pick out the Grade 2, the Grade 3 and the Grade 4 metastases on the basis of roentgenologic appearance. As the only conceivably logical basis for classification depended on the assumption that the more osteoplasia present, the more apt were the metastases to be from a low grade malignancy, the selections of these radiologists were as often wrong as right, and they were unanimously of the opinion that it is not possible to determine the grade of malignancy of the primary lesion on the basis of the character of the roentgenological appearance of the osseous metastases from it.

While this paper is not concerned with a discussion of the value of roentgen therapy applied to the thorax directly postoperative, during convalescence, it is of interest that 35 of the 41 patients had had the benefit of such treatment in some form or other, 22 having had three or more "courses" of treatment, 7 more having had two treatments each. As Leddy states, "It is self-evident that roentgen therapy directed to the thorax in postoperative treatment can have no effect on malignant cells already disseminated outside the fields treated, and that it is of no avail in slowing the growth of those cells already in the spinal column and pelvic bones. Sufficient evidence has not yet been accumulated to justify 'prophylactic treatment' of the spinal column as routine in addition to that of other danger zones. However, from the standpoint of safety alone, the possibility is worth consideration." In at least 2 instances in this series, symptoms of bone metastases appeared during the period of postoperative roentgen therapy to the thorax, obviously illustrating the points made by Leddy.

#### TREATMENT

The status of treatment of bone metastases before the advent of modern roentgen therapeutic methods is characteristically summarized in an article by Osler<sup>51</sup> in 1906. In this he writes that "Scarcely enough stress is laid in works of surgery upon the terminal stages of cancer, with the tragic events of which the general practitioner is left to battle alone . . . . The most common and the most serious, as entailing a maximum of suffering, are the lesions of the spine. . . . Amid the sad failures of our art, these cases stand out in strong relief. An early diagnosis of the condition (bone metastases), and an early recognition of the hopelessness, may lessen the terrible ordeal of the poor victim and mitigate not only her suffering, but those of the near relatives. MORPHINE, enough MORPHINE! given freely and without fear, in doses sufficient to keep the patient comfortable, AFFORDS THE ONLY POSSIBLE RE-

LIEF." Even as late as 1915, Matthews,<sup>48</sup> after an extensive review of the literature on metastatic carcinoma in bone, writes: "I can find no mention of X-ray or radium treatment in these cases," and offers no additional therapeutic advice to that given above by Osler. Various methods of symptomatic treatment by casts, braces, laminectomy, epidural injection of the sciatic nerve, ramisectomy and even chordotomy, have been tried, but the results have been discouraging in all but a few instances, and many of these procedures were applicable in only very selected cases.

In 1907, Freund<sup>21</sup> reported roentgen treatment of a patient with probable metastasis to the pelvis from carcinoma of the breast. This was undoubtedly the first such case reported in the literature, and apparently did not come to the attention of Matthews in his survey. The next report did not appear until 1917, that of Levin,<sup>47</sup> noting marked improvement in a patient with bone metastases, following irradiation of the metastatic area. Two years later there appeared a paper by Pfahler,<sup>53</sup> reporting 4 cases in which patients were made more comfortable by roentgen therapy, and in which life was thought to have been prolonged. He noted recalcification occurring in metastatic areas following treatment. In a later paper he reported the duration of life in 1 case for four years after therapy, the patient finally dying from visceral metastases. He favored moderate dosage of high voltage through many portals. Since this paper appeared, there have been frequent reports, mostly of the same nature, in the literature. Jenkinson,<sup>38</sup> in 1924, reported 3 patients alive after three years and comparatively free of pain. He stated: "To see a patient bedridden and completely paralyzed from the waist down, with no control of the urine or bowels, get up and walk after a course of treatment, is, to say the least, gratifying." He used high voltage roentgen rays, heavily filtered, in moderate doses. Beck<sup>2</sup> in 1924 added a case to those of Pfahler, in which there was complete restoration of the upper ramus

of the pubis on the right side after it had been destroyed by a metastatic growth from the breast. Giles,<sup>23</sup> Holmes,<sup>36</sup> Joly,<sup>39</sup> Lemaitre,<sup>45</sup> Jacobs,<sup>37</sup> Holfelder,<sup>35</sup> Borak,<sup>6</sup> Schlesinger,<sup>61</sup> Lee and Herendeen,<sup>43</sup> Pancoast,<sup>52</sup> Grier,<sup>28</sup> and Ginsburg<sup>25</sup> have reported frequent improvement following treatment by roentgen rays. Of more recent date are the excellent and comprehensive reports of series of such cases by Leddy in 1929, Geschickter and Copeland in 1931, Lenz and Freid in 1931, and Stenstrom and Ericksen in 1932. Papers in 1927 by Desjardins and by Borak in 1930 discuss well the analgesic property of roentgen rays, the latter particularly with regard to their effects on bone metastases. Borak states that roentgen rays can influence solely a pain that has arisen under pathologic conditions, that they act as an analgesic only when they act therapeutically, that they act as an analgesic only so long and only to the extent that they exert healing effects. Drug analgesics such as morphine afford immediate relief for a very limited time. This relief is symptomatic only, through influencing the pain transmitting, nerve conduction mechanism, or through influencing the cerebral pain centers. The effects of roentgen rays in bone metastases never become evident within a few minutes, but only after a lapse of several hours at the earliest, and usually after several days, and often after a period of several weeks,—and continue, even though they may be of a transitory nature, not only a few minutes or hours, but at least for several days and usually several weeks—often several years; or the pain may be relieved permanently. Partial or complete, transient or permanent relief of pain occurs, says Borak, only so far as there is partial or complete, transient or permanent retrogression of the pain producing pathologic process, independent of its nature. Desjardins has stated that there is reason to believe that the relief from pain is due to the release of sensory nerves from pressure by the tumor, although it is conceivable “that nerve cells, which, of all the

cells in the body are the most resistant to irradiation so far as functional or organic damage is concerned, are acted on in a specific manner, and their irritability diminished by irradiation.” As has been mentioned earlier in this paper, Kaufmann and others have observed a zone of inflammation at the periphery of metastatic lesions in bone. Desjardins has said that in irradiation of lymphocytes in general, an effect is perceptible microscopically as early as three hours after exposure. Inasmuch as lymphocytes constitute a large proportion of this inflammatory zone, it is possible that the destruction of such lymphocytes by irradiation may so relieve pressure on adjacent sensory nerves as to remove the chief cause of pain. Leddy feels that this destruction of the inflammatory tissue probably explains the onset of analgesia where it occurs within the first week after treatment, the effect on the carcinoma itself appearing after more than a week. This effect on inflammatory tissue can occur with dosage insufficient to have much influence on carcinoma tissue itself, and Borak suggests that oftentimes relief is only temporary and palliative because it was sufficient to eliminate the immediate cause, the secondary inflammatory filtrate, but not the ultimate cause of the pain, the carcinoma cells themselves. Where relief is of long duration there is probably destruction within the tumor, with some retrogression. Inasmuch as metastases to bones in themselves do not involve organs absolutely essential to life, and as the condition in the bones, with the associated pain, may persist indefinitely until vital organs are attacked or secondary complications have ensued, such as pneumonia, relief such as afforded by roentgen therapy is well justified, and, as Borak states, fills the same rôle as digitalis in decompensated hearts or decompressions in inoperable brain tumor cases.

The average case in the present series first received roentgen treatment 4.4 months after symptoms of bone metastases had appeared. Some received treatment

within a week or two of the onset of pain, and 1 case did not receive treatment until twenty-one months after the first appearance of symptoms indicative of metastasis which was later confirmed by roentgenograms. This latter case was the only one of the series to go more than one year, after definite symptoms had presented themselves, before receiving roentgen therapy. The average time of coming to treatment after occurrence of symptoms varied little with the grade of the primary tumor from which the metastases occurred, being 5.2 months for the Grade 2 group, five months for the Grade 3 group, and slightly earlier, 3.9 months, for the Grade 4 group. Delay in coming to treatment was attributable to various causes such as the mildness and variability of the pain at the onset, misinterpretation of the symptoms, unawareness of what roentgen therapy had to offer in the way of analgesia, or because roentgenograms of the painful areas were negative at first. Frequently the delay was due to economic circumstances, the patient being unable or unwilling to seek aid. Several patients had sought relief through chiropractic adjustments and 2 cases from osteopathic manipulation. Another was treated for rheumatism with typhoid vaccine, and in 1 case tonsillectomy was performed without benefit. Another unsuccessfully sought relief by taking baths at a well known spa.

Treatment was given in all cases primarily for the analgesic action of the roentgen ray, and more than palliation was not expected. By the time dissemination of the cancer is widespread enough to produce gross evidence of bone involvement at some distance from the site of the primary lesion, the possibility of stemming the fatal tide through local treatment to isolated metastatic regions is indeed remote, although it can happen.<sup>24</sup>

The technique of treatment varied in different cases, but was generally as follows: Cross firing in the pelvis through four large fields (one anterior, one posterior, and two opposite lateral fields) at high voltage;

cross firing of the spine at moderate voltage, through large fields on each side of it, the beams converging at an angle of about 45 degrees. High voltage factors consisted of 200 kv., 5 ma., 50 cm. target-skin distance, 0.75 mm. copper and 1.0 mm. aluminum filters, with an exposure time from 60 to 70 minutes (approximately 550 r. measured in air). Moderate voltage consisted of 135 kv., 5 ma., 40 cm. target-skin distance, 6.0 mm. aluminum filter with an exposure time of 25 to 28 minutes (approximately 500 r, measured in air). In later treatments to the same areas the exposure time was frequently reduced. The treatment had to be given slowly in order to avoid severe reaction. One field daily was usually well tolerated.

The analgesic response to treatment was classified under four divisions: (1) complete *relief*, which heading is self explanatory, meaning just as it implies, complete relief of pain following roentgen treatment, coming on immediately or within several weeks of treatment, and lasting an interval of weeks, months or years; (2) *considerable relief*, under which heading are listed those cases in which there was a very marked improvement, often meaning the returning of a bed-ridden, suffering patient to a more normal and satisfactory existence, but in which the relief was not complete, some residual ache or pain persisting, though of relatively minor nature; (3) *partial relief*, in which were put those cases receiving some distinct amelioration of symptoms but not sufficient to justify classification under *considerable relief*; and (4) *no relief*, into which classification were put those cases deriving no benefit from therapy and those cases whose reports after treatment were too indefinite to be certain that any improvement had taken place.

In the 41 patients of the present study treated for relief of pain, definite analgesia was obtained in 35, or 85.3 per cent. In 6 there was no relief. In 29, or 70.7 per cent, of the 41 cases the relief was considerable or complete, and in 14, or 34.1 per cent, it was complete. The type of response to

treatment according to the grading of the primary tumor responsible for the metastasis is shown in Table VI. In each of the three grades studied, a high degree of relief ranging from considerable to complete occurred in the great majority of cases. There is a suggestion that complete relief was of relatively more frequent occurrence in the lower grades than in Grade 4 metastases. On the other hand, there were failures to obtain relief in each of the groups. In general the conclusion must be drawn that the results, according to grade of malignancy, are not enough different to justify the statement that initial relief of some degree can be obtained much more readily in any one grade of malignancy than in another. The pertinent subject of "the duration of relief," however, of which nothing has been said as yet, will appear in the discussion later.

In approximately a third of the cases of *each grade* of malignancy it was noted that improvement began "before completion of the full course" or "within a few days to a week after completion of course." In the remainder the improvement was of gradual onset, occurring within one to four weeks where checked carefully. Maximum improvement obtained from any course of treatment was reached in all instances within one month of the completion of treatment, except in 1 case, a patient with metastasis from a Grade 2 carcinoma, whose response to treatment was more gradual. In this individual, relief of pain occurred gradually over a period of six weeks following a single course of treatment, becoming complete at that time. It is further of interest in this particular case that, with no further treatment, the patient was to all appearances completely well and without recurrence of pain for twenty-four months. The pain was the slowest to disappear and in turn the slowest to re-appear, following a single course of treatment, of any of the 41 cases. It has been observed in the Department of Roentgen Therapy at the Mayo Clinic, in the case of lymphoblastoma, that the more rapid the roentgen

therapeutic response, in general, the more "malignant" the disease, and the earlier the recurrence; the slower the response to roentgen therapy the slower the course of the disease, and the slower to recur. It is suggested that there may be considerable analogy between this response and that of the case reported above.

TABLE VI  
TYPE OF PAIN RELIEF OBTAINED  
BY ROENTGEN THERAPY

	Complete	Considerable	Partial	No Relief
Grade 4 (22 cases)	5	9	4	4
Grade 3 (13 cases)	7	3	2	1
Grade 2 (6 cases)	2	3	0	1
Total (41 cases)	14	15	6	6
Total in percentage	34.1	36.5	14.6	14.6

Knowledge as to the benefit, if any, of giving the treatment early in the disease, soon after the appearance of symptoms of metastases, is of obvious interest. In Table VII the relationship of time of treatment to type of relief obtained is shown.

Patients, 35 in all, obtaining relief of one type or another came to treatment in an average of 3 to 4.5 months after onset of symptoms, and whether the treatment afforded partial, considerable or complete relief, the average duration of symptoms before treatment was approximately the same. Whether the patient had metastases from a Grade 4, Grade 3, or Grade 2 carcinoma of the breast made no difference, the average time of coming to treatment was approximately the same for those of each grade obtaining complete relief, for those obtaining considerable relief, and for those obtaining only partial benefit. The 35 individual cases obtaining relief came to treatment within two weeks to ten months, 32, or 91.4 per cent, receiving treatment within eight months or less. The 1 patient coming to treatment ten months after the onset of symptoms and still obtaining relief had a Grade 2 malignancy and obtained considerable relief of twelve months'

duration. The other 2 patients coming to treatment after more than eight months and obtaining relief had metastases from a Grade 4 malignancy. One patient after nine months received considerable relief for three months following one course, with considerable relief for three months from a second course given after recurrence of pain. The other obtained complete relief for five months from one course of treatment given nine months after evidence of metastases had occurred, and received considerable relief for thirteen more months from subsequent treatment.

exceeding by twelve months the similar period of any other patient in the entire group. Thus, 3, or 50 per cent, of the 6 cases obtaining no relief did not receive treatment until eleven to twenty-one months after the appearance of evidence of metastatic bone lesions, the only 3 patients of the entire 41 to go that long without roentgen therapy to the areas of bone involvement. Explanation of the failure to obtain relief in the other 3 cases apparently lies in another direction.

It would appear from the above facts that while likelihood of obtaining relief or

TABLE VII

AVERAGE TIME INTERVAL (IN MONTHS) BETWEEN FIRST SYMPTOMS OF BONE METASTASES AND SUBSEQUENT ROENTGEN THERAPY OF PATIENTS OBTAINING THE VARIOUS TYPES OF RELIEF

Group	Complete Relief	Considerable Relief	Partial Relief	No Relief
Grade 4 (22 cases)	3.0 (5 cases)	3.9 (9 cases)	3.2 (4 cases)	7.0 (4 cases)
Grade 3 (13 cases)	4.5 (7 cases)	4.0 (3 cases)	4.5 (2 cases)	12.0 (1 case)
Grade 2 (6 cases)	4.5 (2 cases)	3.8 (2 cases)	No Cases	11.0 (1 case)
Total all groups	4.0 (14 cases)	3.8 (15 cases)	3.6 (6 cases)	8.5 (6 cases)

The 6 patients obtaining no relief from roentgen therapy came for treatment at an average time of 8.5 months (Table VII) after onset of symptoms of bone metastases. This average time is in striking contrast to that of the 35 obtaining relief, and the contrast holds within each group of malignancies. The only case failing to respond to treatment in the Grade 2 group was the case in that group having definite symptoms of metastasis for the longest interval of time, eleven months, before receiving roentgen therapy. Similarly, the 1 patient in the Grade 3 group receiving no relief had gone twelve months before receiving treatment, longer by four months than any other case in the group. The 4 patients in the Grade 4 group receiving no benefit from therapy came to therapy after symptoms for periods of one, two, four and twenty-one months, respectively, the latter

palliation following roentgen therapy is considerable if given within eight months, the prospects diminish rapidly after this lapse of time. The type of relief afforded at any time within this period may vary in degree from partial to complete, independent of whether it is given immediately or not until four to eight months after the onset of symptoms.

The duration of the relief, once it is obtained, is of prime consideration to all concerned. Complete relief as obtained in the 5 patients with bone metastases from Grade 4 carcinoma varied in duration from one and a half to ten months (Table VIII).

Case 41 received complete relief from bilateral lumbosacral backache with bilateral sciatic radiation from one course of treatment, and there was no recurrence up to the time of her death one and a half months later from pneumonia complicating



extensive pulmonary metastases. At autopsy, in addition to the vertebral, pelvic and pulmonary involvement, there were metastases to stomach, adrenals, and abdominal lymph nodes, and there were recurrent nodules in the skin of the breast.

Case 32 received complete relief from crippling upper sacral pain for 2.5 months, with occasional recurrent twinges most of the remainder of the year following, and was again "suffering some" by the end of the year.

Case 34 received complete relief of pain in left hip region with radiation down left thigh, for five months, with almost complete relief for seven more months following further treatment, and considerable further relief for four more months; "very comfortable" when last heard from. Roentgeno-

grams after treatment show unusual evidence of bone repair.

Case 26 received complete relief for eight months of right sacroiliac pain radiating into thighs, a second course being given four months after first. There was gradual recurrence with death twelve months after first treatment.

Case 29 received treatment to the dorsal spine over two areas without relief in three weeks, of a pain in this area radiating around right lower costal margin. At time of second visit three weeks later, a second course afforded complete relief which had persisted ten months at last report.

Complete relief of pain, as obtained in 7 patients with bone metastases from Grade 3 carcinoma, varied from two to thirty-one months, 1 of the patients being still alive

TABLE VIII  
TYPE OF RELIEF AND DURATION OF RELIEF IN MONTHS  
FOLLOWING ROENTGEN THERAPY

Case No.	Complete Relief	Considerable Relief	Partial Relief
GRADE 2			
12	24	7* and 3**	
14		12	
20		4 and 2*	
28	Treatment afforded no relief		
30	No relief from 1st course	1½ (2nd course)	** and *** uncertain duration
31	6	3* (3rd course given during this period)	
GRADE 3			
2	6	* (given elsewhere) Duration?	
4	18		* (3 mo. after recurrence) *
5		18	
8	2	6* (2 courses given)	
9	18 (2nd course 6 mo. after 1st)		**
	9*		
16	Treatment afforded no relief		
17	31 (4 courses given)		
18	2		
21		2 (until death)	
35			3 (2 courses)
37	18 (without recurrence to date)		1½ plus
38			
39		2 24* (several courses)	



TABLE VIII (continued)

TYPE OF RELIEF AND DURATION OF RELIEF IN MONTHS  
FOLLOWING ROENTGEN THERAPY

Case No.	Complete Relief	Considerable Relief	Partial Relief
		GRADE 4	
1			$\frac{1}{2}$ plus (duration unknown)
3			2
6		1 and 2*	
7			2
10		5 (3 courses)	2 plus* (2 courses)
11	Treatment afforded no relief		
13	Treatment afforded no relief		
15		6 (2 courses)	* (2 courses) (short duration)
19		$\frac{1}{2}$ *	$\frac{1}{2}$
22		3 and 3*	
23		29 (3 courses—almost complete relief to date)	
24		$1\frac{1}{2}$	
25		$7\frac{1}{2}$ plus	
26	8 (2 courses)		
27	Treatment afforded no relief		
29	10 plus (2 courses—no relief for 3 wk. after 1st)		
32	2 plus		
33		$\frac{1}{2}$ plus	
34	5	7* (2 courses)	
		4 plus**	
38	Treatment afforded no relief		
40		7 (2 courses)	
41	$1\frac{1}{2}$ (until death from pulmonary complications)		

Single asterisk indicates result of additional treatment given after recurrence or exacerbation of pain, two asterisks indicate result of a further course of treatment given after a second exacerbation, etc.

and free from symptoms.

Case 18 within several days obtained complete relief for two months from severe pain in lower back and across hips, remained very comfortable for several more months and then had a gradual return of pain.

Case 8 received complete relief for two months from pain radiating from left ilium into left thigh. Patient returned one year after first treatment with pain severe again and metastases to all lumbar and lower, dorsal vertebrae, pelvis, skull, mandible, femurs, clavicles, scapulae, ribs and humeri at this time. A second course of treatment to entire spine and pelvis furnished consid-

erable relief for three more months, with recurrence of pain in a new area from which a third course of therapy furnished considerable relief for nearly six months. Pain never returned to a severe degree prior to death twenty-eight months after first roentgen treatment.

Case 2. A steady lumbar ache radiating into both thighs was completely relieved following moderate voltage roentgen therapy to lumbar back. Pain was much less even by end of course of treatment. Pain developing in right hip six months later was treated elsewhere with considerable relief reported.

Cases 4, 9, and 37 were all completely re-

lieved of pain for eighteen months. Case 4 was partially relieved for three more months following recurrence. Case 9 obtained nine more months of complete relief and further partial relief, living thirty-nine months after first treatment for severe lumbar pain. Case 37 was relieved within a few days of pain radiating around the right costal margin, and was still free from pain at examination eighteen months later, although metastases appeared more extensive in the roentgenogram than before.

Case 17. Severe lower dorsal backache was relieved completely for thirty-one months by one course of treatment, followed by others at three, eight and twelve months. Patient eventually died of lung complications.

Complete relief of pain was obtained in 2 patients with metastases from Grade 2 carcinoma for periods of six and twenty-four months respectively.

Case 31 received treatment for low lumbar pain radiating into left hip and thigh. Marked improvement was felt by end of course of treatment (five days), and pain was entirely gone within a month, not recurring until six months later, this time with radiation into the right thigh. Repetition of treatment brought considerable relief, lasting until death four months later following a "sudden going to pieces" in which dyspnea and cough were prominent.

Case 13, with ache in lower back and pain running down into both lower extremities, obtained gradual relief, becoming complete in six weeks, following one course of treatment, and remained symptom free for two years. Recurrence of pain was relieved seven months more by a second treatment, and three months further much relief was afforded by a third treatment given after a second recurrence. Fourth treatment after a third recurrence gave little relief, and patient died forty-five months after first course of therapy, in considerable pain prior to death.

Considerable relief was obtained for periods of one to seven and a half months in

8 of the 22 cases with bone metastases from grade 4 carcinoma. In an additional case there has been twenty-nine months (at last report) of almost complete relief from pain. In some of these cases where further treatment was given following recurrence of the pain, additional relief of the same type was obtained, but usually for a lesser period.

Considerable relief of two, three and eighteen months, respectively, was recorded in 3 cases of the Grade 3 group. In the first case this persisted till death; in the second a recurrence was considerably relieved for two more years by repeated treatment, and in the third partial relief was obtained by later treatment following recurrence.

In the Grade 2 group considerable relief was obtained in 3 cases for one and a half, four and twelve months respectively, with added relief from later treatments for shorter periods.

Duration of the partial relief as reported in 4 cases of the Grade 4 group and 2 cases of the Grade 3 group was difficult to evaluate with any definiteness because of the gradual blending of the relief period into the period of increasing, returning pain. In most instances it seemed to extend from several weeks to three or four months.

Where so much varied response occurs, comparison is not easy. However, one-third (2 out of 6) of the Grade 2 group received complete relief for periods of six or more months from single courses of treatment, 5 of the 13 in Grade 3 received similar relief (2 receiving more than one course), while of the 22 in the Grade 4 group, only 2 received complete relief for six months or more, each receiving two courses of treatment. It seems, therefore, that although any type and duration of relief from treatment can occur in cases of any group, the more favorable responses in point of degree and duration will be seen more often among patients with the lower grade malignancies.

An interesting group are the 6 cases obtaining no relief. Possible explanations of reasons for failure are suggested in a review of their histories. As has been mentioned

earlier in the paper, 3 of these, Case 28 (Grade 2), Case 16 (Grade 3), and Case 27 (Grade 4), did not come for treatment until eleven, twelve and twenty-one months, respectively, after the occurrence of symptoms of bone metastases. This delay in receiving treatment undoubtedly was an important factor in determining its result, irreparable radioresistant changes having occurred by the time roentgen treatment was attempted.

Case 28 complained of pain in right hip region, radiation into the limb, and had roentgen evidence of metastasis in the right sacroiliac area. Two treatments with high voltage roentgen therapy were given to the pelvis, front and back, instead of the usual four treatments. It is possible that an additional course of treatment or four full fields might have offered her relief not obtained from her original treatment.

Case 16 likewise received only modified treatment, moderate voltage, three fields over the dorsal, lumbar and pelvic regions, respectively, of the back, for pain between the scapulae and in the lower back. There was roentgen evidence of multiple metastases throughout the spine and near the left sacroiliac region of the pelvis.

Case 27 had root type of pains running into the lower abdomen and into the lower extremities, with roentgenographic evidence of metastases to lumbar spine and pelvis. Here again, only moderate voltage roentgen therapy was used, and to four fields on the mid and lower back.

The 3 other cases obtaining no relief were all of the Grade 4 group. In 1 of these, Case 11, a modification of treatment similar to that in Cases 27, 16 and 28 was used instead of the usual technique. Case 13 had low backache and destruction of the fourth lumbar vertebra and received the usual lumbar spine technique but no treatment to the pelvis. It is possible that the origin of pain may not have been from the fourth lumbar area, but a lower, yet undemonstrable area in the untreated pelvis.

Case 36, the remaining case, received full treatment to lumbar spine and pelvis when

metastatic pain in the low back appeared when returning for her third course of post-operative roentgen therapy to the thorax. There was no relief from pain during the course of treatment, and the only report two months later said patient was losing weight and strength and felt poorly. The case was classified as no relief, though it is possible partial relief may have occurred.

The history of these failures seems to point to the advisability of treating early and treating adequately. Where the site of the trouble may be deep seated as in the pelvis, it would appear that multiple beams of the more deeply penetrating, high voltage origin directed to it from a minimum of four angles is the treatment of choice, and offers the best chance of palliation. Likewise, from the experience in several cases in the series, it seems decidedly worth while to repeat a course of treatment after an interval of three or four weeks if the pain persists and there is strong reason to suspect a metastatic origin.

While much more than palliation of pain is not expected, there are many instances in which there is undoubtedly a prolongation of life, a return at times for months from a semimoribund condition. Meyerding, Carman and Garvin,<sup>49</sup> reporting more than ten years ago a series of cases with metastases to the bones from carcinoma of the breast, stated that the average duration of life after discovery of the bone metastases was 4.7 months (25 cases). In our group, already dead, are 29 cases living for an average of 15.5 months following the first roentgen treatment for bone metastases (Table ix). Allowing to some extent for possible earlier recognition of bone metastases now than at the period of their paper, it would still appear that there is a longer duration of life in the present group, probably, at least partially, related to the roentgen therapy received.

From Table ix it can be seen that the average duration of life following treatment is greater in the Grade 2 group than in the Grade 3 group, and decidedly greater in the Grade 3 group than in the Grade 4 group.

Whether the duration of life, longer in the Grade 2 than in other groups, is entirely due to inherent characteristics of the tumor, or in part because Grade 2 metastases are more permanently affected by roentgen therapy cannot be answered at this time. It can be stated, however, that because patients with Grade 2 and Grade 3 malignancies appear to live longer after metastases to bone have occurred, relief of pain during this interval is of even more importance than in the higher grade, more rapidly fatal malignancy. Furthermore, as has

the osseous metastases. B. The greater the degree of axillary glandular metastases found at operation, the earlier the appearance of metastatic bone lesions.

3. Location or number of metastases bore no relation to grade of malignancy.

4. Roentgenographic appearance of metastatic areas was similar regardless of grade.

5. Roentgenographic evidence of recalcification after treatment was seen in bone lesions of all grades.

6. There was an average of 4.4 months'

TABLE IX  
AVERAGE DURATION OF LIFE (IN MONTHS)  
AFTER ROENTGEN THERAPY\*

	Grade 4	Grade 3	Grade 2	All Grades
Those now deceased	14.9 (15)	20.7 (8)	22.3 (6)	15.5 (29)
Range	2-24	3-38	10.5-45	2-45
Those still living	12.6 (7)	18.4 (5)	None	15.0 (12)

\* Number of patients is given in parenthesis in each instance.

been stated before, the more favorable responses to therapy occur more frequently and more repeatedly in just these cases.

#### SUMMARY

It is realized that this series of 41 cases of bone metastases from carcinoma of the breast is small from which to draw conclusions. It is, however, to date, the largest series of this nature available, and, as far as could be ascertained, the only series of its kind in which classification of malignancy according to Broders was used, and in which there were complete data in every case from the time of the original operation on the breast to the finally reported result of the roentgen therapy given to the bone metastases. In view of these facts the following statements based on the foregoing data appear warranted:

1. The higher the grade of malignancy of the breast cancer, the earlier the appearance of bone metastases.

2. In breast cancer of the same grade:  
A. The younger the individual, the earlier

delay before the average individual received roentgen therapy after symptoms of bone metastases had appeared.

7. Although the higher degrees of relief from roentgen therapy were somewhat more frequent in the Grade 2 and Grade 3 groups than in the Grade 4 group, the likelihood of obtaining some degree of initial relief was about as great in one group as another.

8. The more favorable response to roentgen therapy, in point of both type and duration of relief, was seen to a greater extent among patients with the lower grades of malignancies.

9. Relief in some degree from roentgen treatment was obtained in 35 out of 38 patients coming to treatment within ten months of the onset of symptoms of bone metastases.

10. No relief was obtained from roentgen therapy in any of the three (one from each of the Grade 2, 3 and 4 groups) coming to treatment after a lapse of more than ten months.

11. It is suggested that in the treatment of the pelvic region multiple beams of high voltage radiation directed to it from a minimum of four angles offers the best chance of palliation.

12. The lower the grade of malignancy, the longer the duration of life after the occurrence of bone metastases and after their roentgen treatment.

13. Although palliation was all that was expected, there was undoubtedly prolongation of life in certain individual cases.

14. While many of the above inferences appear true for the various groups of cases considered in toto, it must be re-emphasized that exceptions were not infrequent.

#### CONCLUSION

The course of bone metastases from carcinoma of the breast is, for the most part, similar to the course of the tumor in general throughout the body. The less malignant the tumor, the longer the delay in the appearance of bone metastases, and the longer the duration of life after they once appear. In general, the less malignant the tumor of the breast, the greater the relief of pain obtained from roentgen therapy of its secondary bone lesions, and the longer the remissions of pain so induced.

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# SOME EXPERIENCES IN THE TREATMENT OF BRONCHIAL CANCER\*

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ONE of the greatest difficulties of our modern day therapy of bronchial cancer seems to be our inability to make a sufficiently early diagnosis to assure even a minority of these patients a fair hope of ultimate recovery. In fact, most of the cases are referred when the treatment of the disease can be only palliative. Therefore if we are going to achieve any success from either surgical, radiation or combined therapy, the cases must be referred for treatment in an earlier stage of the disease, even before the commonly accepted sign of manifest atelectasis. This earlier diagnosis will only be possible under a most carefully developed alert consciousness of the possibility of bronchial cancer and should include such case finding methods as annual chest photofluorography of the adult population in addition to the interim examination of any individual displaying any pulmonary symptomatology or other insidious or masked findings which might be even indirectly referable to bronchial cancer. I refer here to those atypical cases with insidious non-pulmonary onset which in a previous survey made by us comprised 15 per cent of a series of 73 cases of bronchial cancer.

Another difficulty is the proper evaluation of any therapy which attempts to deal solely with the local disease in the average case of bronchial cancer because of the commonly observed tendency of such lesions of early vascular dissemination through ulceration into the tributaries of the pulmonary veins. This probability of early and widespread dissemination, in addition to the early lymphatic permeation toward the hilar nodes, brings one face to face with the concept of immunity to cancer cells. In bronchial cancer, especially, it would seem that we must postulate such a

theory of immunity if we are to explain the apparently successful disposal of undoubted myriads of cancer emboli which break into the general circulation, while only a relatively few ever seem able to establish growth and create recognizable metastases.

For some years past we have assumed, in agreement with Fried, a theory of origin of these tumors from basal islands of primordial epithelial cells underlying the bronchial mucosa and have recognized five arbitrary types resulting from such cellular metaplasia. These pathologic types have previously been described by us and will not be dwelt on here.

From a therapeutic viewpoint, the most we can expect to achieve is to maintain the resistance of the host while we attempt to render innocuous any potent mass of active pulmonary disease, either by surgical extirpation or radiation sterilization or by both, so as to prevent further dissemination. Therapy, therefore, to achieve beneficial results should begin early in the course of the disease with the hope that the tumor can be successfully removed or sterilized before generalized metastases have taken place.

Most of our patients were in the fourth to the seventh decade of life. Approximately 30 to 40 per cent had demonstrable metastases to the hilar nodes, opposite lung, bones, superficial nodes or brain. Over one-third were poor risks for any therapy. There is left, therefore, a small group, probably 10 to 15 per cent at the most, to whom exploratory thoracotomy might be applicable. Even in this hopeful group we had difficulty in persuading them against their own set desires and those of their referring physicians that such exploratory operation offers the best hope of cure. The

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result is that most patients either of necessity or desire come to radiation treatment and only a few to surgery. However, in the small number of our cases that have come to surgery, including several referred for postoperative roentgen therapy, we have observed a successful result in one, which will be referred to later.

To date our best results from radiation therapy of bronchial cancer seem to have been achieved with 200 kv. cross fired so as to build up a total radiation of 12,000 r with properly directed and angulated portals, distributed over two anterior and two posterior fields. A supplemental course of similar irradiation after one to two months, through previously unirradiated portals, probably three in number, in order to cross fire into the site of the lesion, may be given. In a few selected cases where the intrabronchial tumor is accessible, gold radon seeds may be implanted through the bronchoscope.

In the supervoltage range, it would seem from our experience so far that good results may be expected especially with 400 kv. and its resulting heavier filtration as exemplified in a case to be herein cited. With 1,000 kv. one might theoretically expect even better results, but so far the results, while immediately encouraging in establishing early palliation and often apparent improvement in aeration, have been ultimately discouraging in that this improvement has been too short in duration. However, improvement in technique may bring about better results in the future.

I wish briefly to report 4 cases where a histopathologically proved malignant growth in the bronchus has apparently disappeared at subsequent bronchoscopic examinations under radiation therapy for a sufficient length of time to make one hopeful that such therapy may and will, if skillfully managed, accomplish lasting results.

#### CASE REPORTS

CASE I. R. L. R., white male, married, aged thirty, occupation a weigh master for a coal company for the past thirteen years, was ad-

mitted to the tumor clinic at the State Institute for the Study of Malignant Diseases on May 24, 1937.

*Chief Complaint.* Chronic cough since 1934 with soreness in left chest and dyspnea. About 1936 cough became more severe, he spit blood and was told the left lung had collapsed. He had previously been admitted to the Buffalo General Hospital in January, 1937, where he had several bronchoscopies, with biopsy, and where a microscopic and clinical diagnosis of bronchial carcinoma was made. He had a series of twenty roentgen treatments there. On discharge he was still troubled with cough and soreness of the left chest. He weighed 149 pounds. The pathological tissue report from that hospital was carcinoma of the left bronchus showing infiltrating small round cells with, in some areas, attempt at gland formation.

*Chest Examination.* Diminished breath sounds over left chest, trachea pulled to left, with sounds almost absent over the lower two-thirds of left chest and percussion note approaching flat. Heart pulled to left, rhythm rapid but regular, no murmurs or increase in size noted. Roentgenogram of the chest showed a large, diffuse, triangular shadow with the apex directed toward the clavicle, occupying the lower three-quarters of the left lung. Right lung was normal. Heart normal in size and contour but displaced to the left. A lateral roentgenogram confirmed the findings in the posteroanterior view and showed dense shadow in the left hilar region with increased linear marking radiating therefrom and some aeration at the base and apex.

From a review of the previous roentgenograms both here and at the Buffalo General Hospital and also the clinical findings and microscopic tissues previously secured, a diagnosis of bronchial carcinoma of the left lower lobe was confirmed.

*Treatment.* From June 10 to July 22, 1937, roentgen therapy was given as follows: 200 kv. at 80 cm. skin target distance, using 10 by 15 cm. fields, 0.9 mm. Cu half-value layer, directed over the left hilar region, two anterior and two posterior, so as to converge in the region of the left hilum. The two anterior fields were treated one day with 200 r each and the two posterior fields the following day and so on until a total of 3,000 r, measured in air, was given over all fields.

On March 30, 1938, the following note was recorded: Patient spent winter in the South. He



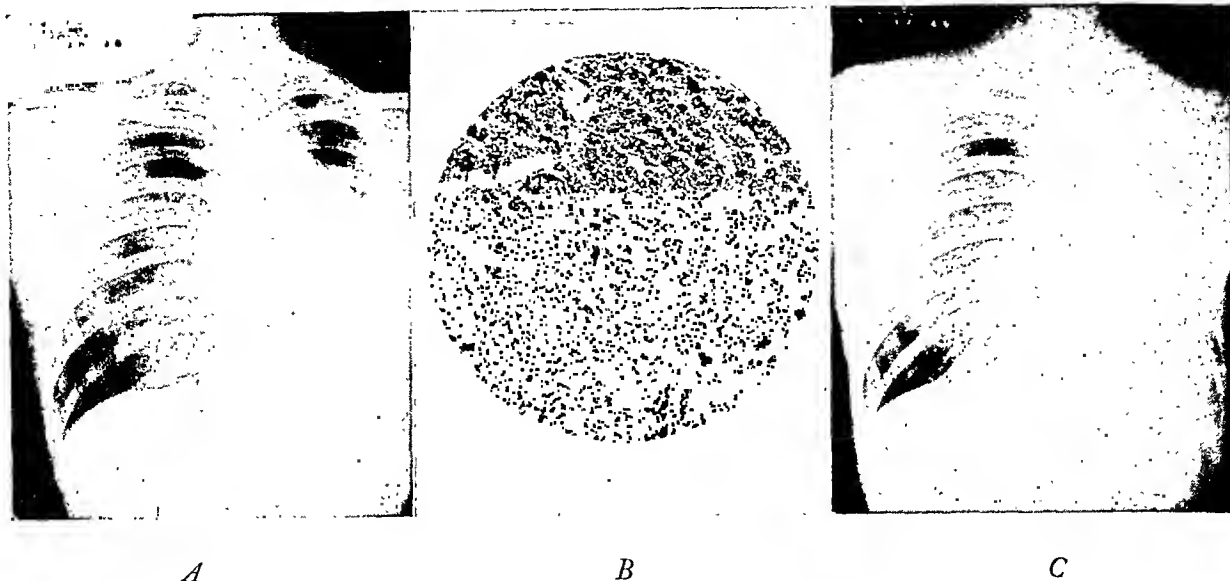


FIG. 1. Case 1. *A*, roentgenogram of the chest on admission. *B*, photomicrograph showing adenomatous tumor. *C*, roentgenogram after pneumectomy.

has a slight cough, feels quite well, no hemoptysis, little skin reaction on chest and no apparent change in the chest roentgenogram.

On September 13, 1938, a bronchoscopy showed the tracheobronchial tree displaced to the left. In the left bronchus about  $1\frac{1}{2}$  inches from the carina there was a coarsely lobulated tumor attached to the lateral wall by a moderately broad base which almost filled the lumen of the lower lobe bronchus. The mucosa over this tumor did not appear ulcerated. The right bronchus and its subdivisions were fairly normal. The base of the tumor mass in the left lower bronchus was transfixed with 1 mc. gold radon seeds and a section taken for biopsy. I was led to believe from the history to date and the appearance of the tumor on bronchoscopy that this was an adenoma, although the pathologist still reported a carcinoma of the small cell type.

On November 14, 1938, the patient maintained a stationary body weight. He had slight dyspnea and only occasional streaking in the sputum. Chest roentgenogram showed increased aeration over the upper border of the dense lower half of the left lung field; otherwise there was little change.

On March 21, 1939, bronchoscopy showed a globular tumor arising from the lateral wall of the left lower lobe bronchus about  $1\frac{1}{2}$  inches from the bifurcation, which filled approximately two-thirds of the lumen. The surface was smooth, not ulcerated and was again reported by me as resembling an adenoma. The base was

again planted with two gold radon seeds of previous size and the mass coagulated through the bronchoscope. The right bronchus was not remarkable. After consultation with the pathological staff it was now conceded that the biopsy taken at this time was not unlike adenoma.

On July 25, 1939, the patient complained of some dyspnea, increasing malaise and some cough. A bronchoscopy was again performed with the hope of instituting better drainage and aeration of the left lower lobe. The adenoma was observed as before below the upper lobe bronchus of the left bronchial tree. An unsuccessful attempt was made to apply a snare about this mass and an exploratory thoracotomy was suggested to the patient which he then refused upon advice of his referring physicians, preferring as they had recommended to continue as he was so long as he was having such satisfactory palliation.

On October 24, 1939, patient was again bronchoscoped to improve aeration and drainage. The left bronchus showed a shelving, partially obstructing mass in the left lower lobe stem about  $1\frac{1}{2}$  inches from the carina. The mucosa over it was roughened but not ulcerated. There was apparently less obstruction. The tumor was again coagulated by me through the bronchoscope and a section taken. Section was again reported adenoma.

On April 9, 1940, the patient again complained of malaise, some low grade fever, night sweats, loss of weight, and so forth, which he had now learned to associate with lack of drain-

age and aeration. Bronchoscopy at this time showed practically little obstruction at the site of the tumor in the left bronchus. The bulk of the tumor had apparently disappeared leaving only what seemed to be a thickened scar of the mucosa. As he said he was getting tired of his recurrent invalidism, exploratory thoracotomy with the hope of removing the fibrotic infected left lower lobe was again suggested. This time the patient consented.

On March 12, 1941, the patient was operated on, a left pneumonectomy being performed at the New England Deaconess Hospital in Boston, Massachusetts, by Dr. R. Overholt. The pathologic tissue, after extensive study of the removed left lung by Dr. Shields Warren, showed a chronically infected fibrotic left lower lobe but no sign of the original tumor in the bronchus. After reviewing the biopsy sections taken here before operation the diagnosis of adenoma was also concurred in by them. When last seen the patient had returned to work and was feeling the best he had felt in years.

Figure 1 shows roentgenograms before and after therapy, and a photomicrograph of the lesion.

**CASE II.** R. F. K., white male, aged forty-nine, occupation clerk, was admitted to the State Institute for the Study of Malignant Diseases tumor clinic with a previous diagnosis of carcinoma of the lung on May 29, 1939.

*Chief Complaint.* Stomach trouble, i.e., nausea and vomiting a year ago which was repeated again six weeks ago. He had lost 5 pounds in

weight and complained of a dry, hacking, unproductive cough. Chest examination showed sonorous rhonchi throughout both lungs, with compensatory breath sounds over the right lung and diminished respiratory murmur over the left anterior middle lung field. The roentgenogram on admission is shown in Figure 2A.

On June 6, 1939, bronchoscopic examination was not remarkable except in the left lower lobe bronchus where in the terminal portion the mucosa appeared thickened and folded. Biopsy showed a carcinoma of small round cell type.

On July 19, 1939, 200 kv. roentgen therapy, as in the previous case, was advised because the patient had refused exploratory thoracotomy. Treatment was started on August 14, 1939, with 400 r daily over the anterior left hilar region, followed by the same dose the following day, and so on, alternating until 3,129 r, measured in air, was given over each field. Treatment had to be discontinued as the patient did not tolerate it well. Treatment was again given November 3 to December 5, 1939, with 350 r daily as before up to 3,910 r total to each field.

On February 21, 1940, on bronchoscopy I was unable to find any evidence of the bronchial carcinoma in the left lower lobe bronchus although the roentgenogram still showed some density about the left hilar region.

On April 17, 1940, the patient had gained 5 pounds, was working daily and was very much pleased with the improvement shown to date.

On June 19, 1940, the patient returned to the clinic after a prolonged illness, apparently, from

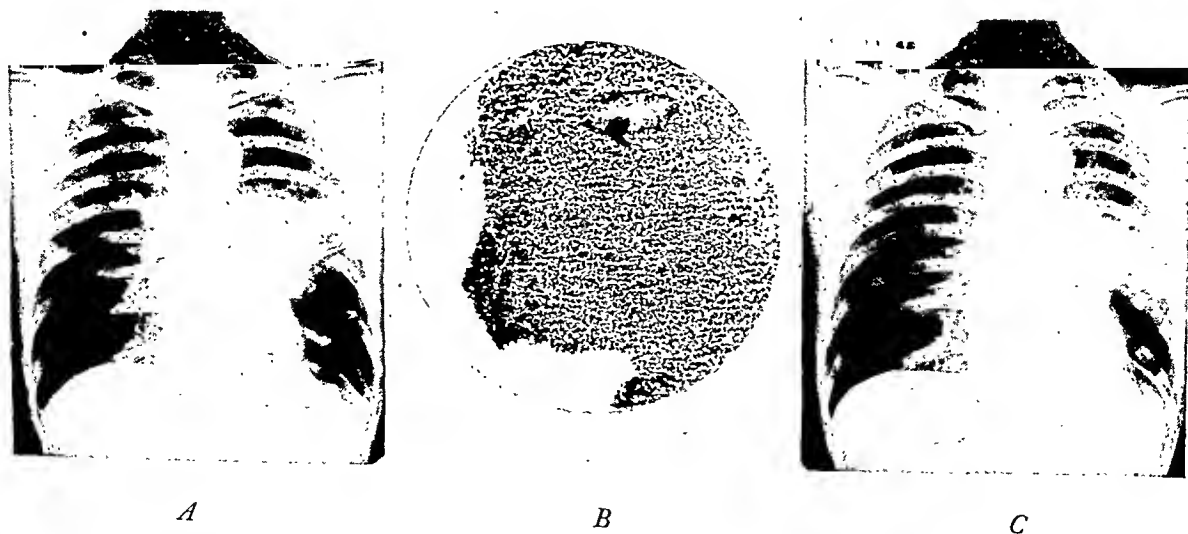


FIG. 2. Case II. A, roentgenogram of the chest on admission. B, photomicrograph showing small round cell carcinoma. C, recent roentgenogram of the chest showing final result following roentgen therapy.

the records of another hospital, a spontaneous pneumothorax of the left lung. He was still weak and would not consent to bronchoscopy.

By July 1, 1940, he had gained considerable weight and was feeling quite well. He still did not wish to consent to bronchoscopy. Roentgenograms showed some improvement.

On May 16, 1942, he felt fine and weighed 130 pounds. His weight has been stationary for some months. He is looking for light work.

nant epithelial tumor, containing "fairly large round cells with large pale nuclei." Mitotic figures were frequent with areas of necrosis. No lesion was then suspected in the upper respiratory tract to account for these findings and the patient had no other complaint. These nodes regressed somewhat following subsequent roentgen therapy, but were still palpable. Chest roentgenogram showed slight density of the left hilum but was otherwise negative.

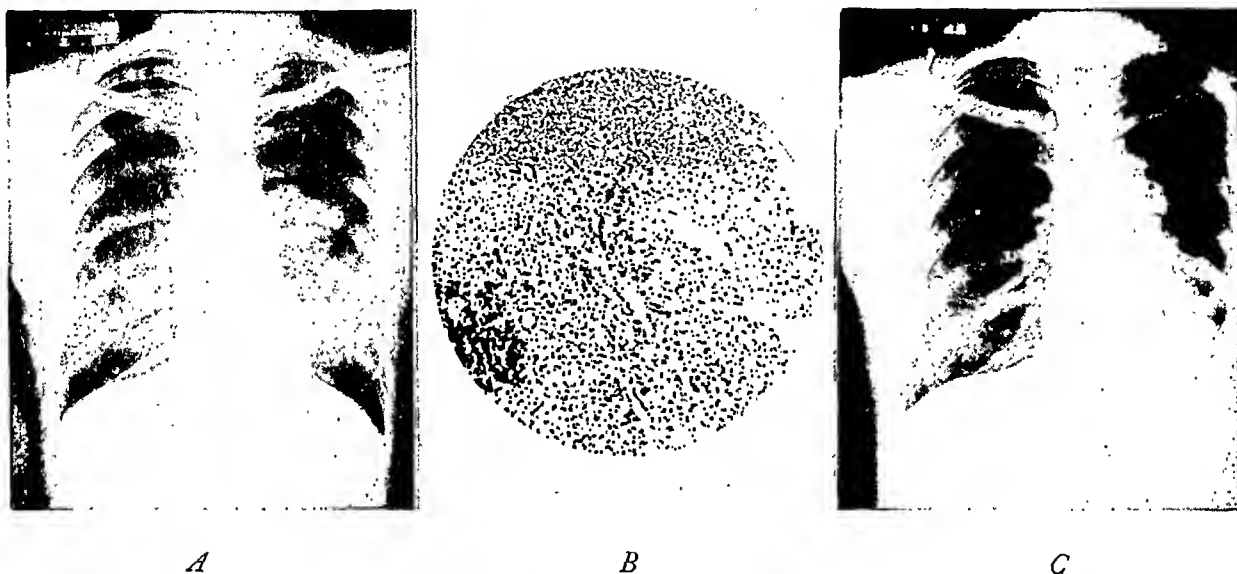


FIG. 3. Case III. *A*, roentgenogram of the chest showing findings on admission. *B*, photomicrograph of section taken from the bronchus showing small round cell carcinoma. *C*, recent roentgenogram of chest following roentgen therapy.

The photomicrograph of the lesion is shown in Figure 2*B* and a roentgenogram of the chest following roentgen therapy in Figure 2*C*.

CASE III. R. D. K., white male, aged thirty-eight, married, engaged as a linotypist for past fifteen years. He was admitted first on February 19, 1937 to the tumor clinic of the State Institute for the Study of Malignant Diseases on account of basal cell epithelioma of the skin of the left ala of the nose. He was again readmitted July 2, 1937, at which time the lesion on the nose remained healed but an indurated node had appeared in the upper cervical region near the angle of the right lower jaw, with smaller nodes running downward along the sternomastoid muscle. A clinical diagnosis of mixed salivary tumor was tentatively made and eight daily roentgen treatments of 400 r each was given over the area with 200 kv. When the mass became larger a biopsy was taken September 10, 1937, which showed metastatic malig-

On May 21, 1940, after remaining without change for some time the patient came in with definite nodes in the left supraclavicular region. He had had pleurisy with effusion since he was last seen and had been tapped three weeks before. There was no recurrence of the basal cell lesion of the left side of the nose. No tumor was palpable in the right neck region but the skin here showed telangiectasia. He had some wheeze, no apparent cough and but slight dyspnea. The pharynx and larynx were negative. Roentgenogram of the chest now showed a large nodular density in the left hilar region extending from its upper portion. The borders were irregular and the markings intensified into the surrounding lung field. No definite changes were seen in the right lung. The roentgenologist suggested a diagnosis of primary bronchial carcinoma and the patient was referred to the bronchoscopic clinic.

On May 28, 1940, bronchoscopy disclosed a tumor arising from the lateral wall of the left

bronchus about 1 inch below the carina. The surface was smooth and suggested an adenoma. Section was taken but otherwise the bronchoscopic examination was not remarkable. Pathologic report was "carcinoma, small round cell type."

From June 24 to July 22, 1940, 200 kv. roentgen therapy was given daily over the density in the left hilar region, as in Case 1, using an anterior superior and inferior and a posterior superior field all converging in the region of the left hilus. Three hundred roentgens, measured in air, was given over the two anterior fields one day and over the two posterior fields the next, alternating in this way up to a total of 3,690 r per field. The patient was quite ill following this therapy but eventually overcame the reaction satisfactorily.

On December 30, 1940, he had only slight cough, no expectoration or hemoptysis, slight "tightness" of the left chest. He has gained 30 pounds and appears to be in good condition. A roentgenogram of the chest showed marked improvement, the density in the left hilar region having greatly decreased.

On March 18, 1941, the bronchoscope was passed without the aid of the laryngoscope at which time the tracheobronchial tree was found to be negative throughout with no sign of malignancy in the left bronchus. The patient weighs 170 pounds, feels fine, works daily as linotypist, and against advice lifts heavy bundles of paper at times.

May 7, 1942. Patient weighs 187 pounds, has no cough, no hemoptysis, no signs of recurrence in the right neck region but there is some telangiectasia of the skin of the neck. He continues to work daily and feels fine. Figure 3 shows roentgenograms taken before and after roentgen therapy and a photomicrograph of the lesion.

CASE IV. C. H., white female, aged fifty-three, school teacher for the past twenty-three years. Admitted to the State Institute tumor clinic on February 11, 1938, with cancer of the right pyriform fossa of the hypopharynx for which she was referred for therapy. She had been intermittently hoarse for the past four months and she also had some difficulty in swallowing. Examination by mirror laryngoscopy showed ulcerated mucosa in the right pyriform sinus region with abductor paralysis of the right vocal cord. There was a hard node

in the right anterior cervical triangle over which there was a skin scar from previous operation for biopsy, which had shown a metastatic epithelioma. Under direct laryngoscopy a papillomatous ulcerated mass was removed from the right pyriform sinus which on section showed an epithelioma of differentiated cell type. A roentgenogram of the chest at this time showed only some calcified nodes in both hila, especially the left, where one approximately 1 cm. in diameter was noted. Roentgen therapy was given using 200 kv. at 50 cm. skin target distance, through a 100 sq. cm. field over the right and left hypopharyngeal region. A daily dose of 200 r was given to one of these fields, alternating right and then left, from February 11 to March 28, 1938, until a total dosage of 6,095 r, measured in air, per field was reached. Following this the patient made an uneventful recovery, showing no signs of recurrence in the right pyriform sinus or any node in the neck on several subsequent examinations, including even direct laryngoscopy. The patient returned to her work as a school teacher.

On October 27, 1941, following complete freedom from the previous condition, the patient was again referred, with a history of losing weight, shortness of breath, dry cough and hemoptysis. She brought roentgenograms which were suggestive of bronchial occlusion, i.e., atelectasis of the left lung. Examination of the right pyriform sinus and upper cervical region still showed no evidence of recurrence, now over three years. Bronchoscopy on October 28, 1941, showed the larynx and trachea to be negative. There seemed to be some forward displacement of the bifurcation. The right bronchus was negative but the left just beyond the carina was occluded with an ulcerating tumor mass.

A biopsy was taken and enough of the occluding mass removed to establish an air way. The histopathologic diagnosis was epithelioma of the bronchus with some keratinization. This was apparently a second primary tumor.

A roentgenogram of the chest at this time showed a diffuse shadow of the entire left lung field except in the left supraclavicular region where there was still some aeration. The left dome of the diaphragm was elevated. The right lung field was practically negative and the left lateral roentgenogram showed increased hilar density extending upward and forward to the chest wall.

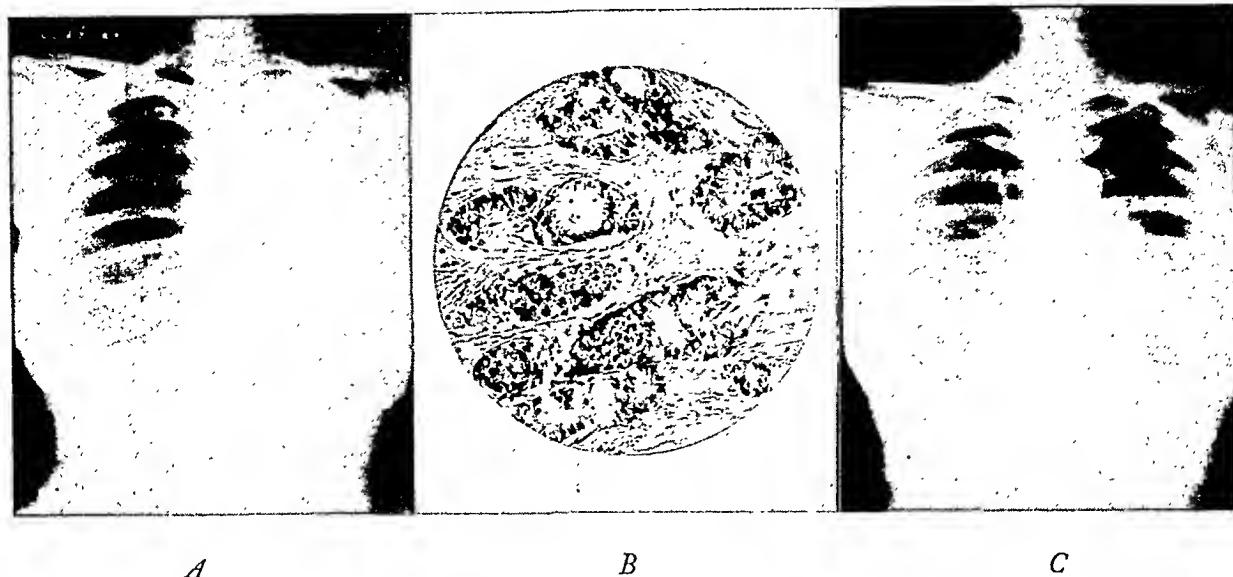


FIG. 4. Case IV. *A*, roentgenogram of chest before therapy. *B*, photomicrograph of section from bronchus showing keratinizing squamous carcinoma. *C*, roentgenogram of chest following 400 kv. roentgen therapy.

Roentgen treatment was given over the left lung, with 400 kv., using an anterior, left lateral and posterior fields at 70 cm. skin target distance. A 10 by 15 cm. field was used in each case giving 100 r through each of the three fields daily. The treatment was started October 31 and continued to December 12, 1941, for 35 cycles with a total of 4,620 r, tissue measured, over both the anterior and posterior field and 3,850 r over the lateral field with all three beams converged toward the left hilum.

The result to date has been an almost complete re-aeration of the left lung, although the left diaphragm is still displaced upward. The heart is also displaced slightly to the left with some residual density in the left hilum. Bronchoscopic examination on April 6, 1942, showed some thickening of the mucosa at the previous site of the tumor in the left bronchus but no signs of recurrence. Figure 4 shows roentgenograms taken before and after roentgen therapy, and a photomicrograph of the lesion.

#### CONCLUSION

The above remarks and citations of four case histories will serve, it is hoped, to portray an impression of our experience in the treatment at this clinic of 147 cases of bronchial carcinoma. While it is still too

early to draw any final conclusions, it would seem that it is possible to produce more lasting palliation or even arrests with radiation therapy than is more commonly reported. In our cases now living, approximately 3 per cent of the total treated, an arrest has been secured for over three to five years in some. Such results, while not entirely unusual, are generally more optimistic than many reports on the surgical, radiation or combined treatment of this condition cited in the recent literature.\*

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\* All patients described in the herein contained case histories are alive and well at the date of submission of this article for publication.



## CARDIAC ANEURYSM\*

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CARDIAC aneurysm, which before the days of the roentgen ray almost invariably eluded diagnosis until the patient came to the autopsy table, has, with the advent of roentgenoscopy and roentgenography come to be described more and more frequently, and with a diagnostic precision which admits of relatively little uncertainty. The great variety of clinical symptoms and physical signs which had previously been accorded some diagnostic merit and which have now been conceded as belonging to a host of cardiac ailments have been relegated to a forgotten niche, and dismissed as never having had much value after all.

Steel<sup>15</sup> comments upon Pletnew's review of 300 cases in 1926. Of these only 6 were diagnosed in life, and in only 1 of the 6 was the lesion visualized by means of the roentgen ray.

The same author points out that among the earliest reports of cardiac aneurysm is to be found that of Olaus Borrich, who in 1676 reported an aneurysm of the right auricle; and of Pierre Dionis who in 1696 reported one of the right ventricle; and of Dominic Galeati who in 1757 reported one of the left ventricle. In 1900 Fujinami reported a case with three aneurysms, one at the apex, one in the posterior wall below the mitral orifice, and one of the septum; Thurman had, in 1838, reported a case in which four aneurysms were found in the left ventricle.

The first roentgen report appears to have been that of Sézary and Alibert<sup>13</sup> in 1922; it is very complete and conclusive, and calls attention to the comparative findings in the oblique positions. The first roentgen report with autopsy confirmation was apparently by Link, in 1927.<sup>10</sup>

## ETIOLOGY AND PATHOLOGY

Almost all cardiac aneurysms are due to coronary thrombosis; among the other very occasional causes must be listed abscess of the cardiac wall, trauma, ulcerative endocardial lesions, and congenital lesions.

Cardiac aneurysm may be found as early as six weeks after a coronary occlusion. In a series of 145 cases reported by Shookhoff and Douglas<sup>14</sup> the average age of the patients was 57.8 years, with only 3 patients in this series being under the age of forty. The authors add a case of their own only thirty-five years of age.

The usual sequence of events appears to be anemic necrosis and myomalacia, followed by fibrosis. Frequently there is a thrombus in the sac. Pleuropericardial adhesions are frequent.

Steel has given an excellent summary of the pathologic findings and of the anatomic structures involved. The left coronary artery arises in the left sinus of Valsalva, and is usually larger than the right. Just below its origin it divides into the anterior descending ramus (which gives off large branches to the ventricular septum and left ventricle, and smaller branches to the left atrium. Anastomoses are common throughout, not only between the right and left coronary arteries in their capillary and precapillary distribution, but also between coronary arteries and vessels of adjacent and attached organs and between branches of each coronary. These anastomoses involve the fine peripheral branches in the subendocardial and subpericardial layers.

Infarcts have a roughly triangular outline with the base toward the endocardium and the apex toward the epicardium; hyperemia and coagulation necrosis are followed by fibrosis, with abundant elastic

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tissue present. As healing progresses the wall of the infarct near the epicardium becomes thinner, the end-result being a white scar.

About 85 per cent of these aneurysms are in the left ventricle; 2 to 5 per cent of them occur in the right ventricle. Other locations may be the interventricular septum, or the sinus of Valsalva.

The aneurysmal wall is usually from 1 to 3 mm. in thickness.

About 80 per cent of cardiac aneurysms occur in males.

Aneurysms situated in the right sinus of Valsalva may perforate into the right ventricle; a few of these are congenital in origin. When acquired, they are often due to ulcerative endocarditis. Aneurysms of the sinus of Valsalva may be intravalvular.

Schwedel and Gross,<sup>12</sup> in a review of 81 cases of cardiac aneurysm, found 3 of the right ventricle, 48 in the anterior or lateral portion of the left ventricle, 21 in the posterior portion of the left ventricle; 24 per cent of the entire series had pericardial adhesions.

Syphilis plays a very minor rôle in the development of these cardiac aneurysms; the total number of reported luetic cardiac aneurysms appears to be about 19 (Braunstein, Bass and Thomas<sup>2</sup>). Cookson<sup>3</sup> has given an interesting account of the pathology in a luetic aneurysm.

In this case, three cavities or aneurysmal dilatations occupied the posterior portion of the left ventricle; their diameters were respectively  $1\frac{1}{2}$  in.,  $\frac{1}{2}$  in. and  $\frac{1}{2}$  in. Their ventricular surfaces were covered with rough, injected granulation tissue; externally they were covered by an area of pericardial thickening. On section the walls were found to consist of fibrous tissue containing considerable deposits of calcium. All the valves were normal; all the coronary branches were patent. The patient was a female, aged forty-three.

In short, the pathology of luetic cardiac aneurysm appears to be the pathology of gumma.

Rupture is rare, death usually occurring

(and that, in most cases, about two years after the diagnosis is made) from another attack of the same sort of coronary occlusion which originally produced the aneurysm. Hunter and Benson<sup>6</sup> have described the pathologic findings in a case of rupture. This patient had had an attack of coronary thrombosis three months before; the aneurysm was situated on the anterolateral wall of the left ventricle. There was a surrounding area of fibrous adhesions 7.8 by 4.5 cm. in extent binding the epicardium and pericardium together. Similar bands obliterated the pericardial space over the surface of a mushroom-like mass situated well up toward the atrioventricular sulcus and between the anterior interventricular and circumflex branches of the left coronary artery. Along the inferior border of this pouch, 1 cm. lateral to a line drawn through its center, was a slit-like ragged-edged opening 4 mm. in length. A probe passed through inside this defect, led through the 1 mm. wall at the base of the aneurysm into its cavity, which lay over the external surface of the left ventricle. The aneurysm measured 4 by 4 by 3 cm.; its wall varied from 1 to 7 mm. in thickness.

#### ROENTGEN FINDINGS

The posteroanterior roentgenogram of the chest gives adequate information in a great many instances, since most of the aneurysms are situated in the left ventricle, and the characteristic shadow is brought out with satisfactory definition. Aneurysms involving the cardiac apex may be elusive unless care is taken to examine this area well in deep inspiration. Roentgenoscopy should, of course, not be dispensed with in any case, even in those in which the diagnosis seems apparent from the posteroanterior roentgenogram. The reason for this caution is well illustrated by the following experience of Sauerbruch,<sup>11</sup> and one which details what is probably the only successful surgical attack upon a cardiac aneurysm:

Sauerbruch, in addressing his clinic, presented a roentgenogram which gave evidence of a mediastinal mass; this mass, he



pointed out, seemed to duplicate almost exactly another one which had been a mediastinal tumor and upon which he had operated at a very recent date. The appearances in the two roentgenograms were so alike, indeed, that Sauerbruch felt confident that the second mass must be a tumor very similar to the first; consequently, he performed an exploratory operation.

Upon dissecting out the mass, Sauerbruch found a cardiac aneurysm; the dissection had already progressed too far to

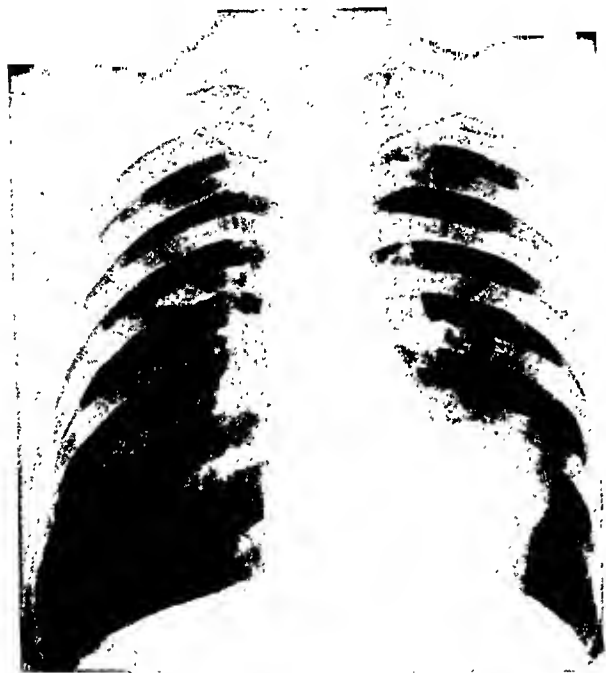


FIG. 1. Left ventricular aneurysm, posteroanterior projection.

permit of closure with no attempt at reparative surgery. This he went about and, reporting the case some weeks later, was able to say that the patient was convalescing very satisfactorily, a plastic operation having been done upon the cardiac wall.

Much stress has been laid upon the "contrapulsatile" expansion of a ventricular aneurysm. This merely means that when the ventricle goes into systole, the aneurysmal sac dilates, taking on a "paradoxical" motion. The value of this sign has no doubt been greatly exaggerated, for many observers have testified that in their cases it was absent altogether.



FIG. 2. Left ventricular aneurysm, right anterior oblique projection.

Brams and Gropper<sup>1</sup> have called attention to the fact that apical aneurysms may



FIG. 3. Left ventricular aneurysm, left anterior oblique projection.



be impossible to diagnose. This may no doubt be true of some of them, but the probability is that the great majority can be found if roentgenoscopy is carefully carried out and care taken to examine the apex with the diaphragm fully depressed in deep inspiration. Aneurysms in the apex have a tendency to develop downward, and will thus come to lie in what the French call *l'ombre hépato-diaphragmatique*. Wiberg<sup>16</sup> records 1 case in which an apical aneurysm produced a depression in the liver, and Lutembacher<sup>8</sup> calls attention to the fact that the apex may become fixed by pericardial adhesions.

Our case was a male, aged fifty-five: one year before he had been operated upon for ruptured duodenal ulcer, and while recovering from this operation had had an attack of coronary thrombosis. He had refused the period of inactivity which his physicians tried to enforce, and insisted upon an early resumption of his work as a truck driver.

Complaining of epigastric distress, he was referred for examination of the gastrointestinal tract. The aneurysm was then seen roentgenoscopically, and roentgenograms were made in the posteroanterior and right and left anterior oblique positions.

He was referred elsewhere for surgery of the aneurysm. The surgical exploration confirmed our description of the aneurysm as being situated on the anterolateral wall of the left ventricle.

The patient did not survive the surgical procedure.

#### SUMMARY AND CONCLUSIONS

1. The majority of cases of cardiac aneurysm follow attacks of coronary thrombosis; other very occasional causes are abscess of the heart wall, trauma, ulcerative endocarditis, and congenital defects.

2. About 85 per cent of the cases of cardiac aneurysm involve the left ventricle; twice as many occur on the anterior as on the posterior wall of the left ventricle. Only about 2 to 5 per cent of cardiac aneurysms involve the right ventricle. Other rarer locations may be the interventricular septum or the sinus of Valsalva.

3. The wall of a cardiac aneurysm is

usually from 1 to 2 mm. in thickness. Despite this, death from rupture of an aneurysm is rare, the patients usually succumbing to another attack of coronary thrombosis.

4. The average life expectancy, once the diagnosis of cardiac aneurysm has been made, is a little less than two years, but in some cases has been as long as seven years.

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# TUBEROUS SCLEROSIS

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**T**UBEROUS sclerosis is a rare hereditary disease of ectodermal origin. Neurofibromatosis and angioma of the brain associated with a nevus in the trigeminal area together with tuberous sclerosis<sup>13</sup> are diseases which show definite clinical similarity and have been classified as "neurocutaneous syndromes" (congenital ectoder-

ceum; (4) nodules in the brain with tendency toward cotton ball calcification, and (5) phacoma of the retina. In addition, there may be multiple skin nodules similar to neurofibromatosis, periungual tumors, rhabdomyoma of the heart, tumors of visceral organs, high and narrow or cleft palate, or other signs of maldevelopment.<sup>3,5</sup>

## SYMPTOMATOLOGY

Patients afflicted with tuberous sclerosis are usually mentally defective and are often imbeciles. Convulsions generally begin in



FIG. 1.

moses). This article is herewith presented in an effort to direct the physician's attention to the clinical and roentgenological aspects of tuberous sclerosis (neurocutaneous syndromes), inasmuch as most authors report that these cases have not been recognized. The majority of reports<sup>10</sup> have originated from European psychiatric institutions. Since Bourneville described the syndrome in 1880, there have been 114 cases<sup>9</sup> reported in the literature.

Cardinal symptoms of tuberous sclerosis are: (1) retarded mental development; (2) epileptic seizures; (3) adenoma seba-

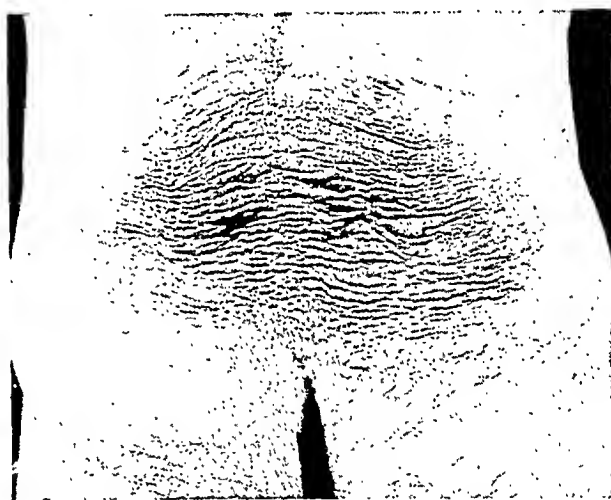


FIG. 2.

the first year of life. The patient seeks medical advice chiefly because of epileptic seizures. Long periods of remission are typical of the disease.<sup>1,2</sup> Critchley and Earl<sup>4</sup> report one case with a remission of seven years' duration. Convulsive seizures may be of the petit, grand mal, or jacksonian type. In spite of the diffuse distribution of cerebral lesions, spastic paralysis and contractions are rare. However, mental deterioration is progressive.

## DERMATOLOGY

Adenoma sebaceum or nevus multiplex of Pringle was described in 1891. It consists of a symmetrical butterfly distribu-

tion<sup>8</sup> of small warty tumors over the nose, cheeks and chin. Color of the tumor<sup>11</sup> varies from that of normal skin to deep red, depending on the number of dilated superficial capillaries present. In addition, there may be pigmentation present in the lumbar area; skin nodules, cafe au lait spots and vitiligo. Some authors<sup>13</sup> are of the opinion that the term adenoma sebaceum is a misnomer because of the fact that the lesions consist of connective and vascular tissue

to three diopters above the retina.<sup>7</sup> Papilledema is absent unless there is an increase in intracranial pressure.<sup>3</sup> Von Hove states that a phacoma may originate from neural

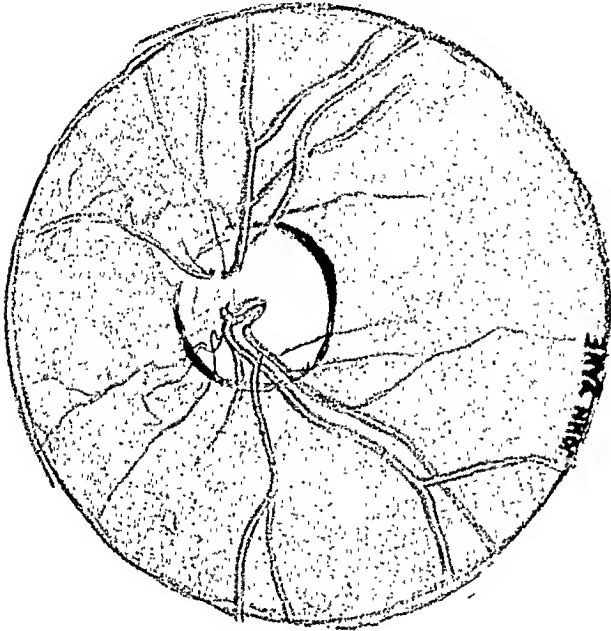


FIG. 3.

hyperplasia. They believe that the lesions often arise from the peripheral glia or Schwann's cells and therefore would be analogous to neurofibromatosis.

#### OPHTHALMOLOGY

In 1920, Von Hove described congenital tumors of the retina associated with tuberous sclerosis. He termed these lesions "phacomias." The tumors appear as small, flat, round, white or yellowish spots on the posterior fundus near the papilla.<sup>8</sup> Occasionally the surface of the tumor spots appears granular and refractile. For this reason, they have been called "mulberry tumors." These tumors are rarely elevated above one diopter, although there have been instances wherein they projected two



FIG. 4.

fibers or neurocytes.<sup>7</sup> He is of the opinion that phacomias occurring in diseases of the neurocutaneous syndromes are closely associated, although definitely of different disease entities.

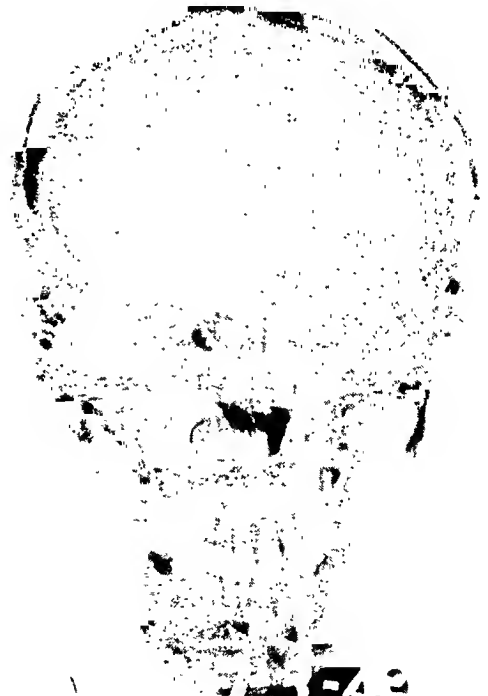


FIG. 5.

## ROENTGENOLOGY

Scandinavian literature is credited with being one of the first to contain reports on the roentgen findings in tuberous sclerosis. Multiple circular nodules of increased density with varying degrees of calcification are seen throughout the brain. Many of the calcifications resemble small cotton balls. Yakovlev and Corwin<sup>12</sup> refer to them as "brain stones." Brain calcifications in tuberous sclerosis should be differentiated from hematomas, tumors, cysts, old abscesses, aneurysms and parathyroid changes.<sup>7</sup> Berkwitz and Rigler<sup>1</sup> have demonstrated that in the absence of brain calcifications pneumo-encephalographic studies may be of value. They report one such case in a two year old epileptic girl wherein pneumo-encephalograms revealed the classical "candle guttering or dripping" as a result of indentation of the ventricular system by the nodules. The septum pellucidum is absent as well. Hydrocephalus may be a pertinent finding.<sup>10</sup> Erosions of the clinoid processes and sphenoid wings<sup>11</sup> as well as hyperostosis interna<sup>7</sup> have been reported. Kveim,<sup>8</sup> and Gottlieb and Lavine<sup>7</sup> have described changes in the spongiosa of small bones. Yakovlev believes that the bone cysts are on the same basis as a schwannoma such as observed in Recklinghausen's disease. Renal tumors in association with tuberous sclerosis are frequently found. Some authors state that they occur in 80 per cent of the cases. Polyposis of the colon may also be present.

## PATHOLOGY

Pathological examination<sup>6,10</sup> of the fresh brain reveals enlarged or flattened convolutions. Multiple, hard, white or grayish nodules in the cerebral convolutions feel like marbles. The ventricular lining presents hard white projections resembling "candle dripping or guttering."<sup>6</sup> Microscopic examination of the affected areas shows giant astrocytes and peculiarly developed nerve cells with many thick processes. These have been classified as spongioblastoma multiforme.

## CASE REPORT

A thirty-two year old white soldier was admitted to the hospital for observation because of a history of epileptic seizures. Patient stated that he had been having "fits" since infancy. These continued until he was six years old. Each attack was accompanied by a period of unconsciousness which was of several minutes' duration. After the age of six, he had as many as six seizures a day. At such times as the patient experienced a "fit," he became weak and had to steady himself against some object to keep from falling. At the age of thirteen, he fell from a horse and for two weeks subsequently was blind, although he could distinguish light from darkness. After the age of sixteen, seizures were less frequent but became more frequent following induction into the Army.

He was graduated from high school at twenty-two years of age. For several years prior to Army induction he was engaged in construction work.

At the present time, he is overemotional; believes that people take advantage of him; yet he is alert and cooperative. Psychological examinations show evidence of deterioration similar to that found in organic brain lesions.

Dermatological examination revealed an acneform eruption over the nasolabial folds, cheeks, nose and forehead. There were multiple flesh colored fibromatous nodules on the left side of forehead, scalp and back (Fig. 1). A large pigmented, hairy nevus occupied the entire lumbar area (Fig. 2). Vitiligo of the left thigh and back was also present. Ophthalmological examination (Fig. 3) revealed that the pupils reacted equally to light and accommodation. Optic discs were pale and waxy. In the left eye there were multiple small, white, waxy areas which appeared adjacent to, superior and nasal to the disc. These areas resembled a colloid degeneration. The waxy granules were compatible with neurological nodules. The remaining physical examination was within normal limits.

Roentgenograms revealed multiple circular areas of increased densities with varying degrees of cotton ball calcification throughout the brain (Fig. 4 and 5). The largest calcification measured 2.25 by 1.5 cm. Calcification similar to that of the brain was also present overlying the fifth lumbar vertebra and right greater trochanter (Fig. 6 and 7). Gastrointestinal and genitourinary tracts and chest were within normal limits. Bones of the hands and



FIG. 6.

feet revealed no evidence of cystic changes. Patient refused encephalography. Urine and stool examinations were negative; blood phosphorus 2 mg., calcium 10.5 mg. per 100 cc. Red and white blood counts were within normal limits. Kahn test was negative.

Microscopic examination of the nodule from the face showed the tissue to be covered with a normal, stratified squamous epithelium, except where there was a down growth of epithelial pegs or large hair follicles. There were numerous sebaceous glands present with small amounts of connective tissue and many large hair follicles which were distended with epithelial debris.



FIG. 7.

A round cell infiltration was present around some of the hair follicles. The histological picture was compatible with a diagnosis of adenoma sebaceum.

#### COMMENT

Tuberous sclerosis, Recklinghausen's neurofibromatosis, and trigeminal nevus with angioma of the brain are distinct types of the neurocutaneous syndromes. Of the three, tuberous sclerosis presents the most clear-cut clinical, roentgenological and pathological picture. Furthermore, it is most constant in patients with mental retardation or epileptic seizures.

Yakovlev and Guthrie<sup>13</sup> believe that the neurocutaneous syndromes are due to congenital maldevelopment of ectodermal structures, namely, nervous system, retina and skin; sometimes visceral organs are involved. Penrose is of the opinion that this syndrome may be due to a single dominant gene which is subject to modification by an autosomal genetic factor.

Delay in the diagnosis of tuberous sclerosis is probably due to the physician's unfamiliarity with the syndrome because of relative scarcity in non-psychiatric institutions. Matthews<sup>5</sup> in a recent discussion of tuberous sclerosis states that 304 out of 335 feeble-minded children were thought to have tuberous sclerosis. The diagnosis of tuberous sclerosis should be considered in every case with mental retardation, epilepsy and especially in those with adenoma sebaceum.

Symptomatology, clinical, roentgenological and pathological findings have been discussed. Visceral tumors are common and should not be overlooked. Heublein *et al.* have stated that if a renal tumor is found in the patient with mental deficiency and epileptic form of seizure, then a complete roentgen examination of the skull, including pneumo-encephalography; and dermatological consultation are warranted.

#### CONCLUSION

A case of tuberous sclerosis in a white soldier, aged thirty-two, has been pre-

sented. The cardinal findings in this case with a history of epileptic seizures were: adenoma sebaceum, fibromatous nodules on forehead, scalp and back, pigmented hairy nevus of the lumbar area, vitiligo of the left thigh and back, phacoma of the retina, and "cotton ball" calcifications of the brain, right greater trochanter and fifth lumbar vertebra.

We wish to express our thanks to Major Frank Duncan and Captain Ervin H. Epstein for the ophthalmological and dermatological examinations, to John Zane for the ophthalmological drawing, and to Captain Harry J. Adams, Personnel Consultant, for the psychological examination. Photographs are reproduced through the courtesy of the Signal Corps, U. S. Army.

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# ROENTGENOLOGIC DIAGNOSIS OF PEPTIC ULCER OF THE ESOPHAGUS

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**A**LTHOUGH esophagoscopy has greatly increased the ease and accuracy with which the diagnosis of peptic ulcer of the esophagus may be definitely established, we believe that careful roentgenologic study is sufficiently accurate for the same purpose in many instances and that because it is far less disturbing to patients, it is the more preferable procedure. We have successfully used this preference in our practice, as will be shown later in this paper. It will be well now, however, to examine briefly and in general the question of diagnosing peptic ulcer of the esophagus.

An excellent presentation of this subject is to be found in an article by Chamberlin,<sup>2</sup> who offers the following diagnostic criteria:

1. The ulcer must be unassociated with systemic disease. This condition is made because of the tendency to call any ulceration of the esophagus a "peptic" ulcer, even in the presence of certain diseases in which an ulcerated mucous membrane is more likely to be a result of the disease than a separate entity.
2. The ulcer must be seen at esophagoscopy or at autopsy.
3. Free gastric hydrochloric acid must be present.
4. The ulcer must be chronic.
5. The symptoms must be relieved by peptic ulcer therapy and dilatation.

Although in our experience we have found all five of these factors important, we feel that some comment is necessary with regard to the last three.

Free hydrochloric acid will be found only in that percentage of peptic ulcers of the esophagus which irritate the acid-producing parts of the stomach. However, we can imagine finding ulcers of the esophagus which could be classified among those peptic conditions not irritating acid production and resulting, therefore, in an acidity.

Concerning chronicity, Winkelstein<sup>6</sup> has

observed the autoptic-controlled healing of the ulcer. We regret that the definite time needed for the healing of the ulcer is not reported.

In severe cases, according to Norgaard,<sup>4</sup> the symptoms are pain behind the sternum or in the back initiated by swallowing, but in many cases not coming on until some time—from thirty minutes to one hour—after meals, or perhaps only after the principal meal; in addition, hematemesis, melena, dysphagia, and vomiting are present. Very often, however, the symptoms will not at all be suggestive of an affection of the esophagus. They may be entirely gastric or sometimes there may be only a slight hematemesis, without other symptoms. Obstruction seems not to occur in the early stages.

Etiologically, Jackson<sup>2</sup> and Chamberlin<sup>2</sup> point out the importance of the coincidence of ulcer and diaphragmatic hernia. Chamberlin stresses the fact that short esophagus and diaphragmatic hernia are the causes for the ulcer and thinks that cardiospasm is more likely to be a sequela of the ulcer, in contrast to the opinion of Roessler<sup>5</sup> who is inclined to look at it as the cause of the disease.

According to Jackson<sup>3</sup> the roentgen examination is usually negative in peptic ulcer of the esophagus. Possibly this is due in some cases to flatness of the ulcer and also to overlapping of diaphragmatic and hepatic shadows. In the Yearbook of Radiology<sup>7</sup> for 1932, in discussing the report by Aurelius<sup>1</sup> the abstractor writes: "Roentgenologic literature is conspicuously lacking on this subject despite the fact that cases have been definitely recognized by roentgenologic examination."

The difficulty in roentgenologic diagnosis of peptic ulcer of the esophagus is in recording changes in the lowest part of the esophagus. This is due to two conditions.



The area in which nearly all described ulcers are found is within the shadow of the diaphragm and vertebrae, or in oblique position, within the shadow of the liver. Very often irregularities in this section are seen during roentgenoscopy but cannot be found on the roentgenogram, as even a heavy barium suspension passes through this part very rapidly. Another reason is that shallow ulcers of the esophagus are often only temporarily filled.

Therefore, we have used in our studies a fluororoentgenographic device<sup>8</sup> as described in a former publication and known under the name of "spot film." We examine the patient at first in the routine manner, then use a fluororoentgenographic device which permits recording esophageal changes during roentgenoscopy. By this means we have been able to find without difficulty or loss of time the exact angle in which the niche in the esophagus can be projected free from any disturbing shadow. In addition, we make the exposure while the patient is in deep inspiration, thus projecting the lesion free from the opacity of diaphragm and liver.

The occurrence of peptic ulcers in the gastrointestinal tract outside the stomach and duodenum is comparatively rare. Peptic ulcers of the esophagus belong to these rare conditions. As this condition is of sufficient clinical importance, we are reporting 2 such cases.

Peptic ulcers of the esophagus have been known since Quinke in 1879 showed that the pathological changes in the esophagus were the same as those in the stomach and duodenum. The diagnosis of this condition can be made in two ways, either by direct examination or by roentgenological examination. The greatest number of cases seen by direct examination is reported by Jackson, who observed 88 cases, 21 of which were active ulcers. Other articles describe one or a few cases. Without doubt diagnoses are most accurate when made by direct visualization of the process. Esophagoscopy, however, is a procedure which causes the patient great discomfort and it

should be performed only by those skilled in its technique. Our object is to show that careful roentgenological examination can demonstrate the lesion with sufficient accuracy.

CASE 1. For fifteen years the patient has experienced constant burning retrosternally, localized to an area about the size of a half dollar, in the region of the xiphoid process. There was

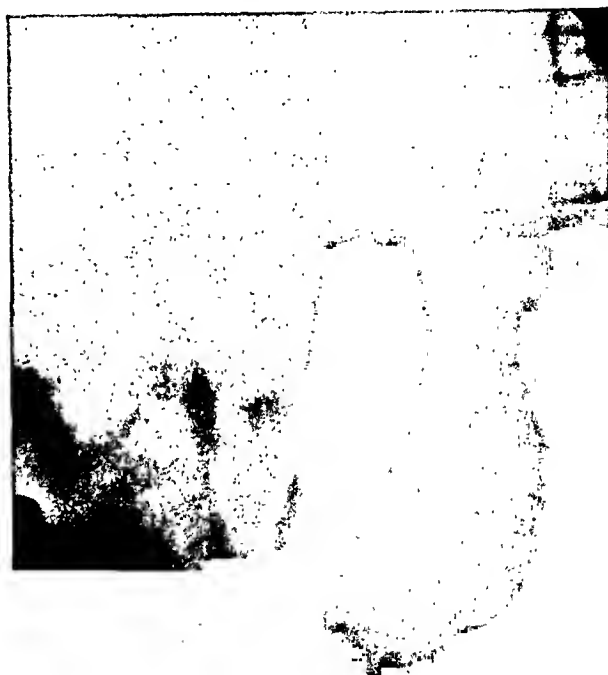


FIG. 1. Case 1. Ulcer of the esophagus, proved by esophagoscopy.

no vomiting; relief was obtained with bicarbonate of soda. At the same time her appetite was excellent and her weight was 220 pounds. About one year ago she began to vomit immediately following two or three swallows of food. At this time the burning occasionally disappeared. The vomitus was undigested material, never blood. She vomited only food, liquids being retained. At present she is able to retain only liquids. During the last three years she has lost weight, especially during the last six months. Her appetite is still excellent, no weakness, feels stronger than when she was heavier.

Roentgenological examination showed the esophagus to be of normal width. There is a slight spasm about 1 inch above the diaphragm.

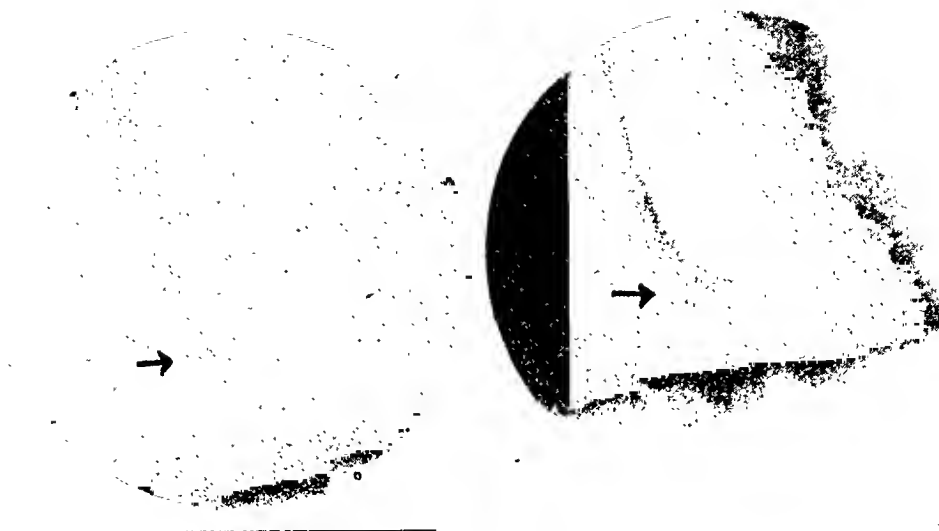


FIG. 2. Case I. Fluororoentgenogram. The shallow ulcer is projected free from the shadow of the diaphragm. Right oblique position.

The borders of the esophagus are smooth. The mucosa shows puckering in its lower third. At the lower pole of the esophagus there is a constant patch. The passage through the esophagus is slightly delayed. However, two glasses of barium pass through. In the right oblique supine position the stomach is entirely below the diaphragm. In the left oblique position the folds of the stomach can be seen above the diaphragm. In the upright position, especially in the left oblique, the mucosa of the stomach can be seen 1 inch above the diaphragm.

Roentgen diagnosis: sliding diaphragmatic hernia; peptic ulcer of the esophagus.

Findings of the esophagoscopy by Dr. Abraham Shorr: The mucous membrane of the

entire esophageal wall shows evidence of a chronic inflammatory change. There is a definite thickening near the second constriction of the esophagus. The esophagus was patent throughout its length. No evidence of tumor masses. There was a definite ulcerated area 2 mm. below the diaphragmatic pinch-cock and 2 mm. above the terminal portion of the esophagus.

Impression: Chronic esophagitis. Peptic ulceration of esophagus with spasm.

CASE II. This patient, aged fifty-two, had complained of substernal pains and heart-burning for the last twenty years. Her appetite was always good. She had no nausea, no vomiting. These burning pains occurred frequently



FIG. 3. Case I. Fluororoentgenogram. Left oblique position.

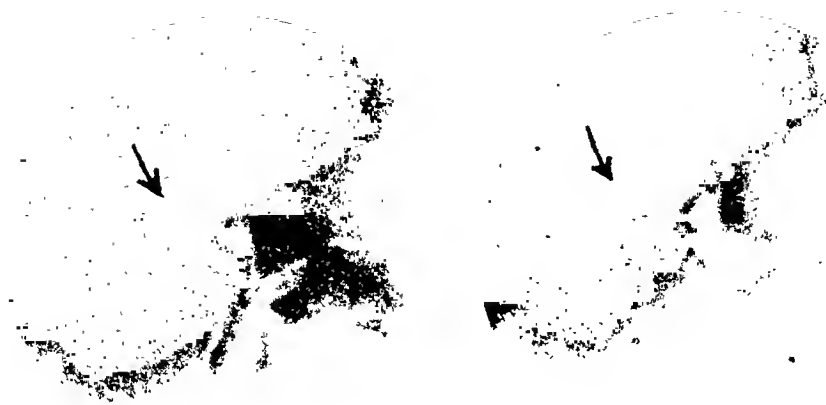


FIG. 4. Case II. Fluororontgenogram of the esophageal ulcer; star formation.

and were especially strong at certain times. She had the subjective sensation that food would stay in back of the sternum for about a minute before it would pass into the stomach. When pains were severe, she lost several pounds but always regained her weight. She never had any vomiting of blood.

The first examination in the spring of 1939 showed that the normal barium mixture passed the lower part of the esophagus in only slightly delayed time. Irregular contractions were seen. The lower part of the esophagus showed abnormal contractions, and the width of the esophagus was only slightly increased. A re-examination in February, 1940, showed that the patient had lost no weight and felt strong. The

sticking pains, which had decreased occasionally under treatment with alkali, had recurred during the last three weeks. The patient was well nourished.

The roentgenologic examination showed only slightly delayed passage through the lower part of the esophagus with a thin mixture. The mucosa of the esophagus was normal. Just above the cardia the esophagus was not dilated normally. With heavy barium mixture, however, irregular contractions could be seen. Special roentgenograms of this region showed a niche in star formation as soon as the esophagus had contracted, and the main portion of the barium had been emptied into the stomach. The importance of this observation is that the niche

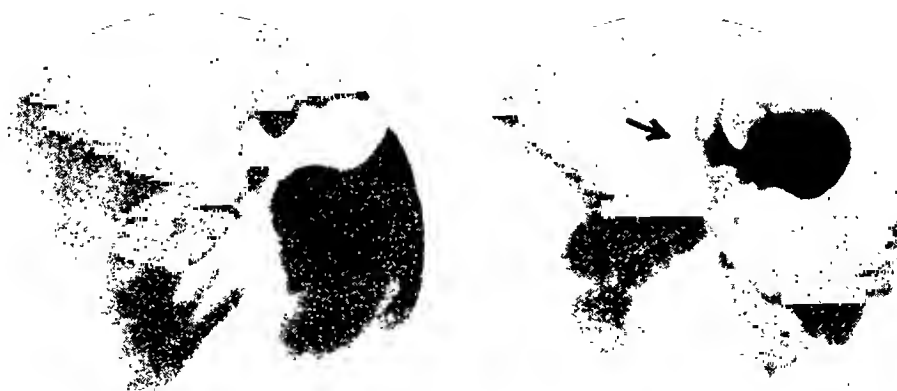


FIG. 5. Case II. Esophageal ulcer.



FIG. 6. Case II. The lower pole of the esophagus. The ulcer is hidden by large amount of barium.

could only be demonstrated after the bulk of the barium had been emptied, which proves that we were dealing with a superficial ulceration which had not developed into scar tissue. Here again the lesion could only be demonstrated after very deep inspiration. The fluororontgenographic device enabled us to demonstrate the peptic ulcer. Autopsy was not performed.

#### DISCUSSION

The importance of the first case lies in the fact that careful roentgenologic examination was able to show a niche just above the cardia at the rear wall of the esophagus. This small niche, however, was not always visible. In certain positions the niche did not fill. In horizontal position we were not able to demonstrate the ulcer; however, in upright position while the patient was in deepest inspiration the niche could be seen several times. During examination when a large amount of barium was taken, the lower portion of the esophagus showed a spastic contraction. This spasm was the first symptom to draw our attention to the need for a more careful study and led us to the discovery of the niche at the rear wall of the esophagus. In order to verify the roentgenologic diagnosis, direct observation by Dr. Shorr was performed. It corroborated our findings.

The difficulty in finding these shallow ulcers in the lower part of the esophagus is

very great. The niche does not retain the barium all the time and, therefore, can only be demonstrated temporarily. It is therefore possible that an esophageal ulcer might easily be overlooked.

We believe that in the second case we were also dealing with an esophageal ulcer, even if we have not the confirmation by esophagoscopy. We find on special roentgenograms a niche toward which three folds are radiating, giving the typical star formation of an ulcer. In this case again, by observation under full filling and after barium passage, we were able to see the lesion. The importance of the examination in "floating rotation," as emphasized by H. H. Berg, is of the greatest value, for otherwise the lesions cannot be demonstrated and fluororontgenographic examination is of great importance for the study of the lower part of the esophagus. By this method, we were able to take roentgenograms at the necessary angle, in the moment of the barium passage, and see on the fluoroscopic screen just the outline which we record on the film.

Chronic substernal pains which are not due to heart or vascular disease are significant of peptic ulcer in the lower part of the esophagus. A careful study of such patients, who up to now were very often considered to be neurotic, might reveal a large number of cases belonging in this category.

## SUMMARY

(1) Two cases of peptic ulcer of the lower part of the esophagus are described. The difficulty of the roentgenological diagnosis of these apparently not very rare conditions is described and the fluororoentgenographic study of these conditions is suggested.

(2) The main clinical signs of peptic ulcer of the esophagus are retrosternal pains and heart burn. Spasm and hematemesis are only secondary conditions in advanced cases.

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# THE NORMAL DISTRIBUTION OF THE SMALL INTESTINE\*

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ACCURATE knowledge of the normal anatomic position of the numerous and tortuous loops of small intestine, if such a normal distribution exists, would be of great value to the roentgenologist and surgeon since it would enable them to localize disease of the small intestinal tract with some degree of confidence. They could determine the exact level of small intestinal obstruction, predict what loops were to be found in the various types of hernial sacs, and locate with some degree of dependability the level of small intestinal new growths, ulcerations, inflammations and adhesions. In view of the great value of such knowledge, it is rather remarkable that so little work has been done in this field in recent years.

Prior to the work of Treves<sup>7</sup> (1885), of Henke<sup>3</sup> (1891), and of Mall<sup>5</sup> (1898), it was generally believed that there was no such thing as a normal position of the small intestine. Most anatomists took for granted that these tortuous coils moved about the abdomen from quadrant to quadrant, rarely staying in any one place for any length of time. However, in 1898 Mall proved that this was not the case. He demonstrated in dogs that loops of small bowel had certain definite positions to which they returned if experimentally displaced. To do this, he operated on dogs, opened the peritoneal cavity and displaced a loop of small bowel. Several days later upon reopening these animals he found that the displaced loop had returned to its original position. This work was confirmed by Hertzler<sup>4</sup> in 1913. There is, therefore, some experimental evidence for the belief that there is a constant distribution of small intestine, at least in the same individual. Whether there is a constant arrangement when we compare one individual to another is a different

matter, and one which deserves further consideration.

In 1885 Treves, in an attempt to help the surgeon locate the many loops of small intestine, started the work on this subject. He studied 100 freshly autopsied bodies. He fixed brass tags to visible loops of the small intestine and then traced the position of these loops in relation to the quadrants of the abdomen. The intestine was removed and the distance of the various brass numbers from the duodenum was noted. The summary of the work can best be given in one of Treves' opening sentences. "The work was laborious, the results were scanty." He felt that definite localization of the loops of small intestine to quadrants of the abdomen was not possible. For example, in the pelvis it was not unusual to find loops lying together that were as much as 12 feet apart. Extremes in the left iliac region were from 2 feet to 23 feet; the right iliac region from 9 feet to 28 feet; and the left lumbar region a few inches to 15 feet. He found that the position depended upon the size and shape of the surrounding organs, especially the stomach and colon. In one case of carcinoma of the pylorus, where the stomach was tremendously enlarged, all but 3 feet of the small intestine was found in the pelvis. He pointed out that the intestine was disposed in an irregularly curved manner from the left upper quadrant to the right lower quadrant. He discounted, however, the value of this arrangement as an aid to the surgeon.

In 1891, Henke continued the work on this problem. He is given credit by Mall for making the first real attempt to locate the position of the small intestine. Henke divided the abdomen into four compartments: subdiaphragmatic, pelvic, right and left lumbar. With these divisions in mind

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he located the various loops of small intestine in 3 cadavers, but could come to no definite conclusions. In view of the small number of cases studied, and the complexity of the problem, this is not at all surprising. He did note, however, that the course of the loops on the right side of the abdomen tended to be vertical, whereas the course on the left was horizontal.

In 1894 Sernoff<sup>6</sup> attempted to clarify the work of Henke. He hardened the intestines with chromic acid, and when they became fixed in position he made casts of the hardened coils. He was unable to come to any conclusion as to a normal pattern of arrangement. In 1896 Weinberg,<sup>8</sup> using the method described by Sernoff, studied the small intestine of newborn infants rather than adults, but like Treves, Henke and Sernoff who preceded him, his results were inconclusive.

It was not until 1898 that a working conception of the normal position of the small intestinal coils was elaborated by Mall. He attacked the problem from both the embryologic and anatomic viewpoints. This enabled him to grasp the difficult problem much more easily than any of his predecessors. He found that in the very early embryo he could subdivide the small intestine into six segments. He watched the development of these segments into loops and coils as he followed them from the smallest embryo to the newborn infant. Thus, having an embryologic basis from which to work, and a general concept of the nature of the development, he could attack the problem more comprehensively. For this purpose, he studied 41 cadavers which had been fixed in phenol. Bodies which showed evidence of peritoneal adhesions were not included. In 21 of these 41 cadavers, he found what he considered to be the normal distribution of the small intestine (Fig. 1).

*Loop 1* (the duodenum) was relatively constant.

*Loops 2 and 3* were confined to the left upper quadrant.

*Loop 4* passed through the midline at about the level of the umbilicus to the

right upper quadrant and then recrossed the midline to the left lower quadrant, where it became loop 5.

*Loop 5* then descended into the pelvis and became loop 6.

*Loop 6* filled the pelvis, the right iliac fossa and the lower abdominal cavity.

It should be noted that in spite of the fact that Mall established this normal position, only 21 of 41 cadavers, or 50 per cent of the cases studied, adhered to the pattern.

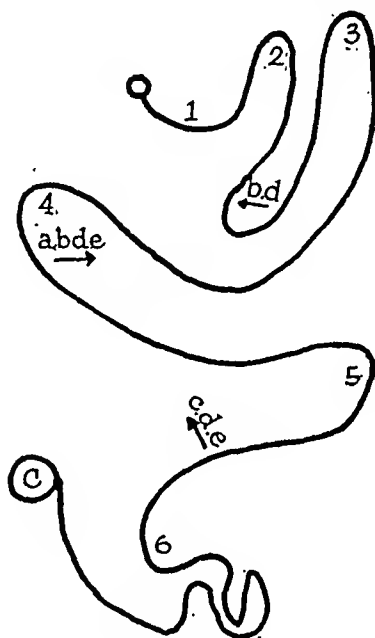


FIG. 1.

The other 20 cases were arranged as shown by the arrows in Figure 1.

Hertzler (1919) studied 1,187 cadavers in which he traced the small intestinal coils after the method of Mall. He found that 75 per cent of the cases studied showed the "normal" arrangement described by Mall. He felt, however, that regular as the arrangement of the small intestinal coils may be "it is not sufficiently so to meet the requirements of the surgeon; since he must recognize the segment of gut at best through a small incision."

In 1927 the problem was attacked from the roentgenographic standpoint by The Cole Collaborators.<sup>2</sup> After following the course of barium through the small intestine in a great number of cases, they found what they believed was the normal config-



uration of the small intestine. This they felt substantiated Mall's findings. From similar roentgen studies, however, Chamberlin<sup>1</sup> (1939) was unable to confirm this work. He felt the variations were too numerous to establish any normal distribution of intestinal coils.

It is obvious from the preceding sum-

habitus of each was determined by tracings of the subcostal angle. The series was divided arbitrarily into three groups: hypersthenic, sthenic and hyposthenic, depending upon the nature of this angle. The abdomen was divided into five regions: right upper quadrant, right lower quadrant, left lower quadrant, left upper quadrant, minor pelvis. The supracristal plane was used to separate the upper from lower quadrants. A loop of small intestine was selected at random from each of the five regions and was identified by tying a colored ligature about it, different colors being used for each region. In 5 of the cadavers instead of choosing a loop at random, *all* the loops in each region were identified by colored strings. Thereafter, a schematic drawing of the configuration of the small bowel with a particular reference to the five regions was made. The small intestine distal to the duodenojejunal flexure was removed by cutting the mesentery at its attachment to the gut. The total length of the specimens was measured, and the distance of each colored ligature from the duodenojejunal flexure was determined.

#### FINDINGS

An attempt was made to classify the cases studied according to the plan described by Mall, but too many variants were encountered so that it was necessary to modify his basic groups. They were reclassified as follows (see Fig. 2 and 3):

*Group (1a)* This group corresponds to the "normal" described by Mall. Loop 1 (duodenum) is relatively constant. Loops 2 and 3 fill the left upper quadrant. Loop 4 passes through the midline at about the level of the umbilicus to the right upper quadrant; then recrosses to the left lower quadrant to become loop 5. Loop 5 descends into the pelvis to become loop 6. Loop 6 fills the pelvis. The terminal ileum then ascends to the cecum.

*Group (1b)* This group corresponds to variation (c) of Mall. It is the same as (1a) except that loop 6 ascends from the pelvis to help fill the right lower quadrant.

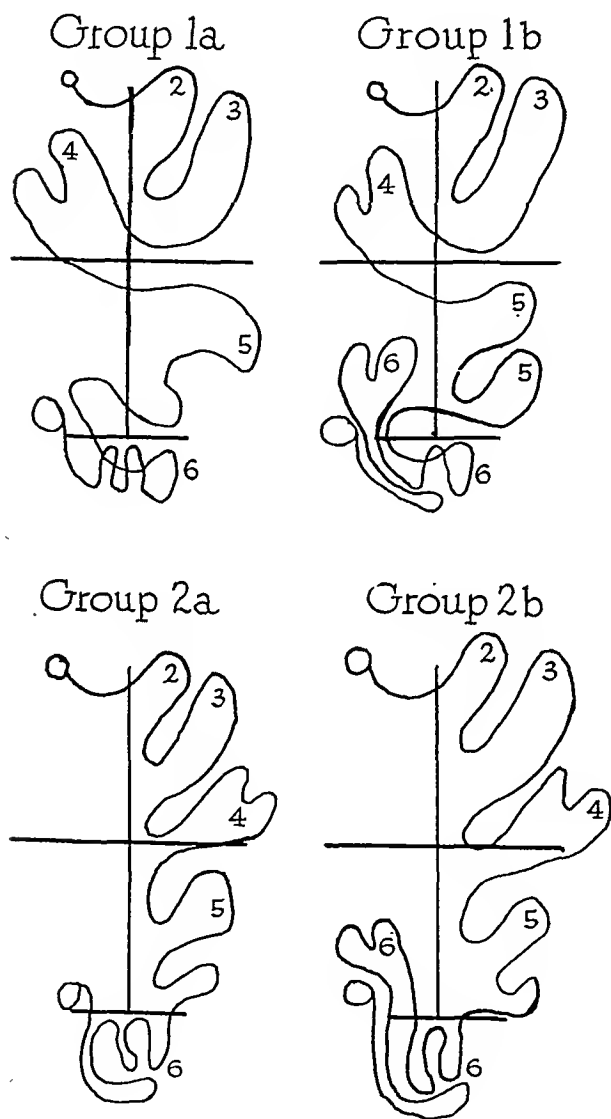


FIG. 2.

mary of the past work, that there is no general agreement on this problem. Since many of the standard textbooks of anatomy accept Mall's findings, and since some roentgenologists today base their work on these results, it was decided to re-investigate the problem.

#### METHOD

Fifty-four cadavers were studied. The

*Group (2a)* This group corresponds to variation (a) of Mall. Loop 4 instead of occupying the right upper quadrant is found on the left side. No small intestine is present in the right upper quadrant (except duodenum).

*Group (2b)* This group corresponds to variation (e) of Mall. It is the same as (2a) except that loop 6 ascends from pelvis to help fill the right side of the abdomen.

*Group (3a)* This group corresponds to variation (b) of Mall. Loops 2 and 3 cross immediately to the right upper quadrant, and loop 4 takes their place on the left side of the abdomen. This is a heterogeneous group in which there are many minor variations.

*Group (3b)* This group corresponds to variation (d) of Mall. It is the same as group (3a) except that small intestine ascends from the pelvis to fill the right lower quadrant.

*Group (4a)* This group does not correspond to any in Mall's series. Loop 4, instead of recrossing to the left, descends directly into the pelvis where it remains with loops 5 and 6.

*Group (4b)* This group does not correspond to any in Mall's series. This is the same as (4a) except that gut arises out of the pelvis to fill the left lower quadrant.

Each of the (b) groups differs from its respective (a) group merely in that portions of the small intestine rise out of the pelvis to help fill the lower quadrants. It is obvious that these variants may be dependent upon certain physiologic and pathologic conditions, such as distended bladder or rectosigmoid, enlarged uterus, tumor masses, etc.

*Group (5)* has no corresponding group in Mall's description. This is a group of 3 cases in which the jejunum (loop 2 and 3) descends to the pelvis and loops 4, 5 and 6 fill the pelvis from which they ascend to fill the lower quadrants. This group is unusual in that they are the only cases in which the terminal ileum came down to meet the cecum from above, rather than ascending from the pelvis to do so.

There was one isolated case which could not be placed into any of the preceding groups. In this cadaver there was no small bowel in both upper quadrants. The duodenojejunal junction was in the left lower quadrant and most of the small intestine was found in the pelvis. The number of ex-

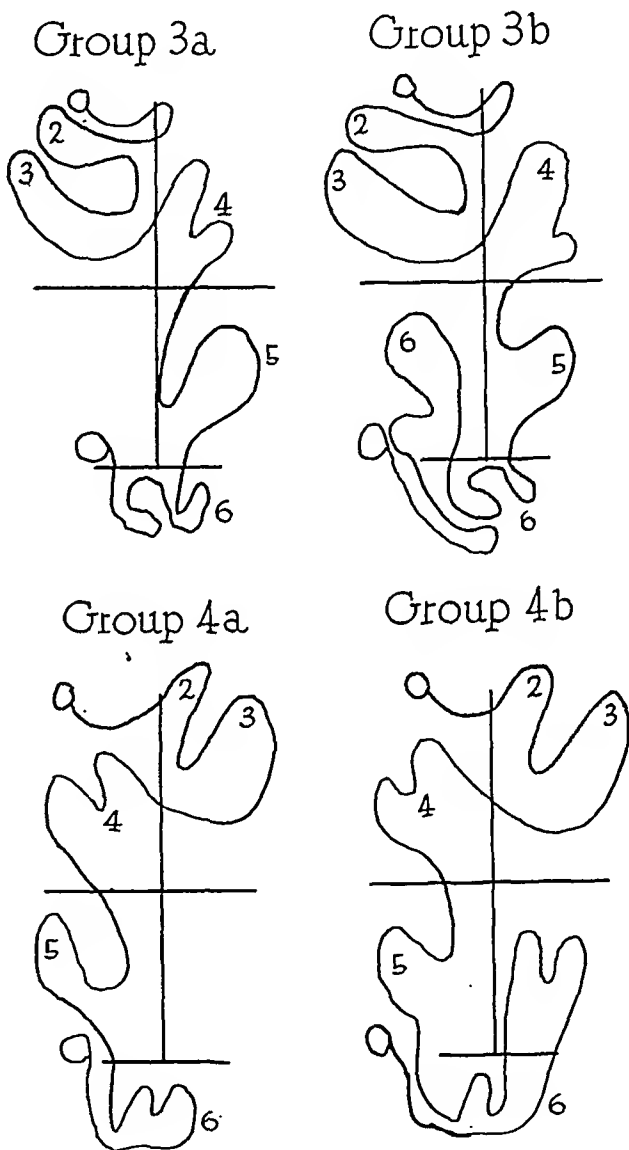


FIG. 3

amples of each group are given in Table 1, and the findings are compared with those of Mall.

It was expected that some relationship might be found between these various groups and their habitus, but this was not the case. There is a slightly greater tendency for small intestine to be absent from the right upper quadrant in hyposthenic in-

TABLE I

Group		Frequency		Per Cent	
This Study	Mall	This Study	Mall	This Study	Mall
1a	normal	7	21	13	50
1b	(c)	5	5	9	13
2a	(a)	5	6	9	15
2b	(e)	12	1	22	3
3a	(b)	12	6	22	15
3b	(d)	0	2	0	5
4a		7	0	13	0
4b		2	0	4	0
5		3	0	6	0
Unusual anomaly		1	0	2	0
Total		54	41		

dividuals. Aside from this rather questionable relationship, habitus seems to play no significant part in the distribution of the small intestine.

The total length of the bowel varied from 10 to 30 feet. The average for the hypersthenic group was 19 feet; sthenic, 16.5 feet, and the hyposthenic, 15 feet. In spite of this apparent association, many of the intestines in the hyposthenic group were considerably longer than those in the hypersthenic group, so that no definite conclusions could be drawn from so small a series of cases.

The distance of the various colored strings from the duodenojejunal junction was measured and great variations were en-

TABLE II

Total Length	Left Upper Quadrant (green)	Left Lower Quadrant (red)	Right Upper Quadrant (yellow)	Right Lower Quadrant (brown)	Pelvis (purple)
Case I 22 ft. 3 in.	2' 3' 9" 5' 3"	2' 6" 3' 2" 4' 5' 9"	6" 6'	1' 4" 9' 2" 22' 2"	4' 7" 6' 5" 11' 4" 14' 1" 17' 6"
Case II 11 ft.	7" 1' 1' 2" 2'	1' 10" 3' 4' 4' 7"	5" 2' 6" 7'	6' 6' 10" 7' 4" 8' 2"	3' 6" 8' 7" 9' 9' 11" 10' 9"
Case III 30 ft. 1 in.	3" 1' 3" 2' 6"	1' 9" 3' 9" 6' 2" 9' 9" 12' 1"	20' 6" 22' 1"	4' 11"	7' 3" 13' 1" 19' 6" 23' 7" 24' 2" 29' 10"
Case IV 18 ft.	1" 5" 5' 9"	3' 9" 4' 3" 4' 8" 7' 10"	12' 6"	1' 3" 11' 4" 14' 3"	9' 9" 16' 2" 17' 2" 18'
Case V 14 ft. 6 in.	6"	3" 10" 1' 2" 1' 6"		6' 3" 13' 11" 14' 11"	3' 1" 3' 8" 5' 3" 9' 12' 3" 12' 9"

countered. For example, the red string which signified the left lower quadrant was found to be 2 feet 6 inches from the duodenojejunal junction (12 per cent total length of small intestine) in one cadaver and 15 feet (75 per cent total length) from the same point in another. Similar variations were encountered in other regions.

In the 5 cadavers in which many strings were tied in each region, loops were found lying together which in the outstretched gut were as much as 20 feet apart (Table II).

#### CONCLUSIONS

1. Although, as Mall indicated, definite patterns and groups are recognizable in a study of the small intestine, these are not sufficiently constant to be of any clinical value.

2. Unlike Mall's series, no predominant group is to be found.

3. There is no relationship between any of these groups and their habitus, so that there is no way to determine beforehand what group we are dealing with.

4. It is impossible to predict the distance of a loop from the duodenojejunal junction by its location in the abdomen. There is, therefore, no anatomic basis for hoping that one can localize the distance of

a small intestinal lesion from the duodenojejunal junction by its position in the peritoneal cavity.

The authors wish to express their appreciation to Dr. Donal Sheehan for his helpful suggestions and criticisms.

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# THE POSITION OF THE SMALL INTESTINE AS DETERMINED ROENTGENOGRAPHICALLY

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THE primary purpose of this study was to determine whether the distribution of the small intestinal loops in the living varied in any way from that found in the cadaver.

One hundred adult individuals were studied serially after the ingestion of 250 cc. of barium sulfate suspension, with 14 by 17 inch films in the prone posture at fifteen minute intervals for the first two hours and at thirty minute intervals thereafter until the barium reached the cecum. It was not as easy to trace the course of the barium-filled loops in the living as it was to trace the loops in the cadaver. It was therefore impossible to classify the results into as many anatomical groups as described in the preceding cadaver study.<sup>1</sup> Instead, it was decided to subdivide the 100 cases into three groups on the basis of certain definite positional characteristics. Age, sex and habitus were not found to be factors in the determination of these groups.

*Group (1):* Consisted of those cases in which loops 2 and 3 were on the left side of the abdomen and in which loop 4 crossed to the right upper quadrant. There were 49 such cases.

*Group (2):* Consisted of those cases in which there was no small bowel present in the right upper quadrant. There were 31 such cases.

*Group (3):* Consisted of those cases in

which loop 4 was absent from the right upper quadrant and in its stead either loop 2 or loop 3 or both replaced it. This resulted in early crossing of the small bowel to the right upper quadrant. There were 20 such cases.

When the 54 dissected cadavers described in the previous paper<sup>1</sup> were reclassified on this basis there was noted a striking similarity in percentages:

	Roentgen Study per cent	Cadaver Study per cent
Group (1)	49	42
Group (2)	31	33
Group (3)	20	25

## CONCLUSIONS

On the basis of our comparative study, it can be stated:

(1) that no significant changes take place in the position of the small intestinal loops after death;

(2) that it is impossible to determine roentgenographically the distance of any small intestinal lesion from the duodenojejunal junction from its location in the abdomen, except for those obviously very near to the duodenojejunal junction;

(3) that it is impossible to classify the position of the intestinal loops on as complete a basis as is possible by dissection of the cadaver, and that even if it were possible, it would have no clinical application because of the great variability.

<sup>1</sup> Herstone, S. T., and Freund, S. Normal distribution of the small intestine. *AM. J. ROENTGENOL. & RAD. THERAPY*, July, 1944, 52, 46-51.

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# SPINAL EXTRADURAL CYST (DIVERTICULUM OF SPINAL ARACHNOID)

## REPORT OF A CASE

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IN 1934, Elsberg, Dyke and Brewer reported 4 cases of spinal extradural cyst with compression of the spinal cord. Previous to their report most of the extradural cysts recorded in the medical literature were either dermoids or due to echinococcus. They concluded that they were dealing with a definite clinical entity which they described as follows:

The individual is an adolescent with the history and symptoms of a progressive spastic paraplegia. Pain is absent or is not a prominent symptom. The objective disturbances of sensibility are slight and their upper level is in the mid-thoracic region, usually at the sixth or seventh thoracic dermatome. The manometric tests demonstrate a subarachnoid block with characteristic spinal fluid changes of cord compression. Measurements on anteroposterior x-ray films show that the interpedicular spaces of three or more vertebrae somewhere between the fourth and the tenth thoracic vertebrae are enlarged. The pedicles of the affected vertebrae especially those of the sixth, seventh and eighth, are narrowed and atrophic.

In 1937 Cloward and Bucy demonstrated that, with one exception, all reported cases of spinal extradural cyst which gave rise to symptoms during adolescence were associated with deformities of the thoracic portion of the spinal column, usually kyphosis of the type seen in Scheuermann's disease, and often referred to as vertebral epiphysitis.

In 1941 Adelstein reviewed the existing literature on the subject and collected data

on 17 cases of spinal extradural cyst, including an unreported case of his own. We have found the following cases reported in the literature in addition to those listed by Adelstein: 1 reported by Turnbull in 1939, 1 by Meredith quoted by Mayfield and Grantham and an additional case included by Mayfield and Grantham in 1942. Therefore, the report of a case which follows apparently represents the twenty-first instance of this interesting condition to be recorded. Our case is especially interesting because of the fact that our patient is older than most (only 2 patients listed by Adelstein were older) and because the communication of the cyst with the subarachnoid space was demonstrated preoperatively during the course of the roentgenologic examination following introduction of radiopaque oil into the lumbar subarachnoid space.

## REPORT OF CASE

A man, aged forty-two, first came to the Mayo Clinic in September, 1941, because of weakness in the left lower extremity. He could not remain to complete his examination and was not seen again until April 19, 1943. Except that he had been "round-shouldered" since the age of fifteen years, and that he had experienced "rheumatic pains" in the left hip at the age of eighteen years, he had been entirely well until the onset of his present illness.

In 1933, at the age of thirty-four, the patient had begun to complain of "clumsiness" of the left foot and leg associated with a "stiff feeling" involving the toes and plantar surface of the

foot. This weakness and stiffness progressed slowly, so that by 1938 the entire left lower extremity was involved. At this time he began to experience similar sensations in the right foot and leg. It was not until his examination in 1941 that he realized that there was actual sensory loss in the lower extremities. At no



FIG. 1. *a*, posteroanterior roentgenogram made with patient's head lower than his feet. The radiopaque oil is blocked opposite the eleventh thoracic interspace and there is an extradural collection of oil on the left. Erosion of the pedicles of the eleventh and twelfth thoracic vertebrae is shown. *b*, lateral view showing the posterior location of the extradural oil. The slight wedging of the bodies of the lower thoracic vertebrae is similar to the changes seen in *kyphosis dorsalis juvenilis*.

time had there been disturbance of sphincteral control.

Our examination in 1941 disclosed a Brown-Séquard syndrome on the left side below the first lumbar segment. Loss of strength, amounting to 50 or 60 per cent, and atrophy of the muscles supplied by the second to the fifth lumbar and the sacral nerves were noted on the left. There was also slight loss of strength of the muscles supplied by the nerves from the eighth thoracic to the first lumbar. Sensory loss was limited to the fifth lumbar and first sacral dermatomes. The sensations of pain, temperature and pressure were decreased about half, while the vibratory and proprioceptive sensations were somewhat less affected.

The sensory level on the right extended up to and included the first lumbar dermatome. The changes were less marked for the first and

second lumbar segments than for those lower down.

Deep reflexes were hyperactive on both sides, those on the left being greater than those on the right. Babinski, Chaddock and Mendel-Bechterew signs were present bilaterally. The right cremasteric reflex was decreased, while the superficial abdominal reflexes were normal.

Lumbar puncture on September 23, 1941, disclosed incomplete subarachnoid block with 30 mg. of total protein and 2 cells per cubic centimeter of cerebrospinal fluid.

At the time of the patient's second visit, in 1943, the findings on neurologic examination were about the same, except for additional weakness of the right lower extremity.

Roentgenograms of the lower thoracic and lumbar regions showed eroded pedicles of the eleventh and twelfth thoracic vertebrae. Very minor changes in the bodies of the lower thoracic vertebrae similar to those found in *kyphosis dorsalis juvenilis* are noted in retrospect. Five cubic centimeters of radiopaque oil were introduced into the lumbar subarachnoid space and a roentgenoscopic examination car-

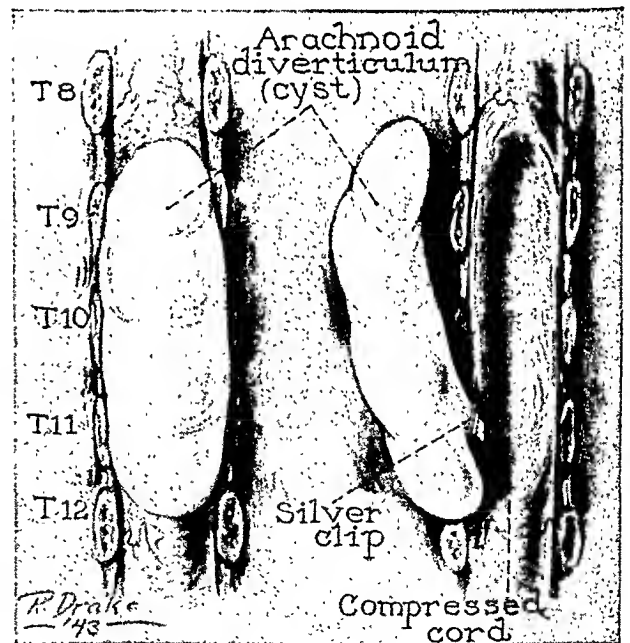


FIG. 2. The cyst, its relation to the cord and its communication with the subdural space.

ried out. With the table tilted so that the patient's head was lower than his feet a complete block to the flow of opaque material was encountered opposite the eleventh thoracic interspace. At the same time it was noted that some



of the radiopaque oil collected outside the usual limits of the subdural space (Fig. 1, *a* and *b*). This collection was on the left side opposite the eleventh thoracic interspace, and was shown to be posterior to the cord by examination in the lateral and oblique positions.

Immediately after contrast myelography bilateral laminectomy was begun. With the patient under ether anesthesia the spines and arches of the eighth, ninth, tenth, eleventh and twelfth thoracic vertebrae were removed. A thin-walled cyst was disclosed, lying posterior to the cord, and extending from the eighth thoracic to the first lumbar vertebra (Fig. 2). It was easily separated from the underlying dura except at one point of attachment on the left side opposite the eleventh thoracic nerve root. The cyst communicated with the subarachnoid space of the spinal canal. It then became apparent that the cyst was a diverticulum of the spinal arachnoid. The cyst was inadvertently opened, and radiopaque oil and cerebrospinal fluid were seen to escape.

The cyst, which measured 7 cm. in length and 2 cm. in width, was removed after the neck, which communicated with the spinal arachnoid, had been closed with a silver clip. The defect in the dura was closed with a silk suture. Roentgenograms of the partially deflated cyst showed it to contain radiopaque oil (Fig. 3) and the pathologist reported the wall of the cyst to be made up of arachnoid membrane.

The patient's postoperative course was uneventful. Immediately after the operation, there was no material change in the motor and sensory functions, but as time has elapsed, gradual improvement has been observed.

#### COMMENT

In most of the reported instances of spinal extradural cyst the patient has been in the adolescent age group. Including our case, only 3 patients were older than twenty-six years of age, and the majority have been less than twenty years of age. Male patients outnumber female patients four to one. Symptoms have been present for as short a period as three months and for as long as twelve years. Almost all of the cysts have been located in the middle or lower thoracic region. In Meredith's case the cyst was reported to be in the cervical region and in 2 other cases, though it orig-

inated in the lower thoracic region, it extended into the lumbar region.

Since the cysts originate laterally near the emergence of a spinal nerve root the symptoms of weakness and spasticity at the onset frequently are noted in the lower extremity on the same side. Soon after this,

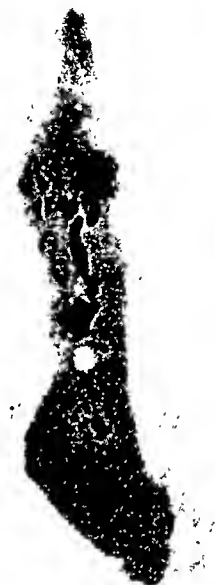


FIG. 3. Roentgenogram of cyst after removal. Some of the radiopaque oil remains within the partially deflated cyst.

the opposite lower extremity is affected. This paraplegia is accompanied by a sensory level which is frequently indistinct. Disturbance of sphincter control may or may not be present. Pain is usually absent. Remission of symptoms may occur spontaneously or after orthopedic measures directed at relieving the dorsal kyphosis.

If consideration is given only to the history and physical examination, a diagnosis of multiple sclerosis or other degenerative process may be considered. Examination of roentgenograms of the spinal column, however, and the results of lumbar puncture will soon reveal the true nature of the lesion. Manometric tests often show either partial or complete block to the flow of cerebrospinal fluid, and an increase of the total

protein content of the spinal fluid may be noted.

Roentgenograms may show changes which are pathognomonic. Enlargements of the spinal canal, together with the changes of kyphosis dorsalis juvenilis in the bodies of the involved vertebrae are not found in any other condition. If the symptoms of compression of the cord begin after the bony development of the vertebral column is complete, the changes of kyphosis dorsalis juvenilis do not occur. Cloward and Bucy have reported 1 such case. The pedicles of more than one vertebra show erosion of their inner margins, and these changes may extend for the entire length of the cyst. As was noted in our case, radiopaque oil introduced into the lumbar subarachnoid space may demonstrate the extradural character of the cyst in addition to the usual signs of tumor. Demonstration by means of radiopaque oil of the communication between the cyst and the subarachnoid space has been reported previously by Teachenor and by Elsberg, Dyke and Brewer (Case 3).

Probably the most important factor in

arriving at the diagnosis by means of the roentgenologic examination is to remember that such a condition exists. In our case all of the signs were present, although the evidence of kyphosis dorsalis juvenilis was minimal, but the true nature of the lesion was not suspected until the radiopaque oil was seen to enter the cyst at the time of the roentgenoscopic examination.

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# THE ROENTGEN INTERPRETATION OF THE PATHOLOGY IN POTT'S DISEASE\*

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IN THE field of diagnostic roentgenology the classical roentgenographic appearance of Pott's disease (narrowing of the intervertebral disc, collapse of the vertebral bodies, with or without the shadow of a "cold abscess") presents as specific and as accurate a picture of the actual pathology as in any disease entity. However, during the past ten years when we have had the opportunity to study various types of tuberculous spines, we have found that the classical description, pathologically, and necessarily, therefore, roentgenographically represents only a partial picture of the disease. In a recent study<sup>1</sup> we have found that the roentgenogram frequently underestimates the number of vertebrae involved, and, often enough to be disconcerting, misses extensive involvement completely. It is the purpose of the present study to describe the various types of pathological changes in the tuberculous spine and to correlate the roentgenograms of these same lesions, in order to explain the discrepancies.

## MATERIAL

The necropsy examination of 1,545 tuberculous patients at Sea View Hospital disclosed the presence of Pott's disease in 132 cases (9 per cent). Of these, 100 had had roentgenographic studies made of the spine, usually less than six months before death. In the following study where errors in roentgen interpretations exist, they are considered of no importance unless the roentgenograms were taken within six months of death.

## AGE

The youngest individual in this group was two years old; the oldest, sixty-seven. Seventy-two cases (55 per cent) were in the second and third decades of life, an age dis-

tribution which is at variance with that usually reported in clinical studies. Wullstein's<sup>10</sup> compilation of his own statistics, together with those of Mohr,<sup>6</sup> Drachmann,<sup>5</sup> and Vulpius,<sup>9</sup> disclosed 85.3 per cent of all clinical cases of Pott's disease occurring in the first two decades of life. On the other hand, pathological studies (Brenner,<sup>3</sup> Billroth and Menzel<sup>2</sup>) reveal an age distribution similar to ours, probably because tuberculous spondylitis is a relatively benign disease, many cases undergoing healing. Those that do not, progress slowly and reach the pathologist at a much older age.

## RACE

Seventy-two (55 per cent) of the 132 cases were Negroes, 57 (43 per cent) were white and 3 (2 per cent) were Chinese. Since the ratio of Negroes to whites in our general necropsy material is 4.7, this preponderance of Negroes is especially striking.

## PATHOGENESIS

It is generally accepted that tuberculous involvement of the skeletal system occurs by way of the blood stream. However, the origin of the tuberculous bacilemia and the mode of localization of the organisms in the bone has been the subject of much controversy.

Since the vertebral disease is of hematogenous origin, it must result from an active tuberculous process elsewhere in the body. Accurate determination of the location of such a process is difficult since the skeletal involvement may be present for a long period before a diagnosis is made. Brenner<sup>3</sup> found that 45 per cent of 39 cases of tuberculosis of the spine were undiagnosed during life, although some of them showed extensive destruction of the vertebrae. Roentgenographic studies of these patients

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were not made. Of our 132 cases, 49 (37 per cent) were undiagnosed during life, although the lesion was suspected from clinical evidence in 18 of these.

The associated pathologic condition is an aid in establishing the origin of the bone lesions. There was an active chronic pulmonary process in only 35 (26 per cent) of our cases, although it seemed possible that a hematogenous dissemination from the lungs might have occurred. Most often, however, the clinical and pathological findings indicated that the skeletal tuberculosis was the older process.

Similarly, a hematogenous dissemination may occur from a tuberculous involvement of the urogenital system. The coexistence of skeletal and urogenital tuberculosis was found in 38 (29 per cent) cases. In many of these, the urogenital disease antedated the skeletal tuberculosis; in some, the opposite was true.

In 11 cases, both chronic pulmonary tuberculosis and urogenital tuberculosis were present together, which leaves 80 cases (66 per cent) in which there was no definite source of hematogenous dissemination to the spine. This leads us to believe that involvement of the skeletal system most frequently is related to the primary complex. The hematogenous dissemination occurs while the primary complex is fresh, and ceases with its healing or encapsulation. Evidence for such dissemination is found in the old hematogenous foci in the apical portions of the lungs, as well as the presence of encapsulated caseous calcified foci in the liver or spleen. The bone marrow is a frequent location for the seedings of the tubercle bacillus when the organism gains access to the blood stream. In routine sections of the spine removed at necropsy from tuberculous patients, miliary and larger foci were frequently found where generalized hematogenous seedings were found elsewhere in the body. The smaller foci tend to be entirely cellular, while the larger show central caseation. The miliary foci may go on to anatomic healing; the larger may go on to progression. When this occurs, an isolated

organ disease of the vertebra results, which by its extent or contiguous involvement of the soft parts produces clinical and roentgenological signs of disease.

#### PATHOLOGY

*Number of Vertebrae Involved.* In only 6 of our 132 cases was there involvement of a single vertebra. Two vertebrae were involved in 39 (30 per cent) cases, the vertebrae being adjacent in all but one instance. In 24 cases (18 per cent) three adjacent vertebrae were involved. In the remaining 63 cases (48 per cent) multiple lesions were found. When multiple vertebrae were affected, the disease was usually, but not always, found in contiguous vertebrae. In general, destroyed vertebrae occurred contiguously, while the skipped lesions showed productive changes. The most extensive process we observed extended from the body of the fifth cervical vertebra to the coccyx.

*Distribution.* The lower dorsal and lumbar vertebrae were most frequently involved, followed in order of incidence by the sacral, lower cervical, and upper cervical vertebrae. There was a gradual rise in frequency of involvement from the fifth to the eighth dorsal vertebrae; a rapid rise in the lower dorsal and upper lumbar region, and a gradual fall in incidence in the lower lumbar and sacrum. Our findings are in agreement with the majority of statistics in the literature.

*Location.* The pathologic appearance of the bone in the early stage of the lesion indicates that the process develops first in the vertebral body, the intervertebral disc being involved by direct extension. As Cleveland and Bosworth<sup>4</sup> have explained, the reason for this probably lies in the anatomic character of the intervertebral joint spaces, which, lacking capsule or synovial lining, are relatively avascular. The hematogenous origin of Pott's disease would therefore appreciably diminish the chances of the disc being involved initially.

The lesion usually appears in the anterior aspect of the vertebral body, rarely in the

central, posterior portions, or in the small parts.

*Gross Appearance.* Recently, we pointed out<sup>1</sup> that the appearance of the bone may assume two distinct forms, a productive (sclerotic) or an exudative (caseous, destructive). If multiple vertebrae are involved, some may illustrate one type, some the other, and in still others both forms are present. We have found an essentially productive form existing in many vertebrae; usually the predominantly exudative type has productive elements at the periphery

tion of varying size develop within the yellow areas, the liquefied areas consisting of soft gelatinous material and frequently bony fragments. With progression of the liquefying process, usually with extension into the intervertebral disc, compression of the vertebra by the body weight occurs and a gibbus results. In occasional cases sequestration of bone may be produced, by a caseous process, encircling either normal bone or bone showing productive changes. In these cases, the sequestrum maintains its integrity, bathed by liquefied material.

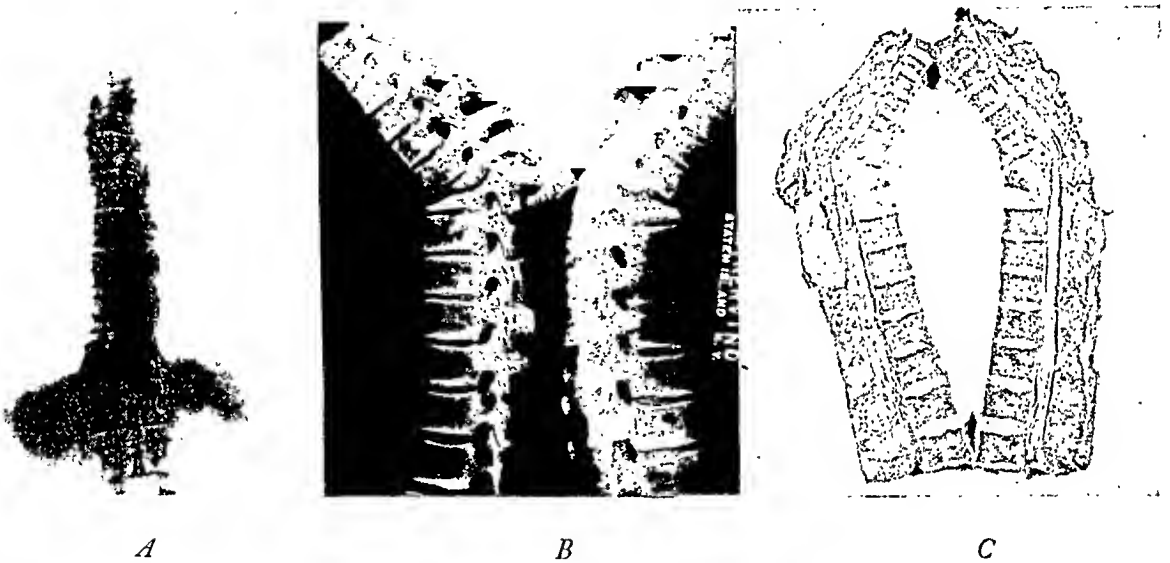


FIG. 1. Destructive Pott's disease of fifth and sixth dorsal vertebrae. *A*, antemortem anteroposterior Potter-Bucky view. *B*, postmortem lateral view, same technique, of hemisection of same spine. No additional information is added to that found before death. *C*, postmortem photograph confirms the roentgenographic diagnosis. Section taken for histological examination from seventh dorsal vertebra.

of the caseous areas to a greater or lesser extent.

*Productive Form.* In all stages the bone assumes a yellow color, these yellow areas gradually extending towards the posterior aspect and the intervertebral disc. The bone is firm and maintains its morphological integrity though the entire vertebral body be involved. The intervertebral discs are intact.

*Exudative Form.* The appearance of the exudative type, since it is more dramatic and more easily demonstrable, constitutes the classical picture of Pott's disease. Here, as in the productive lesion, the bone assumes a yellow color. Soft areas of liquefac-

Microscopically the two types of lesions are essentially what one would expect. In the productive form, tuberculous granulation tissue, rich in capillaries, fills the marrow spaces. This granulation tissue may erode but never completely destroy the bony trabeculae. Within it, there may or may not be areas of caseation, which, however, are walled off from the trabeculae by the productive elements. The reason, therefore, why the bone, though extensively involved, is not collapsed, is obvious.

In the exudative type, the general microscopic appearance is that of large areas of caseation which have completely destroyed all normal bony architecture. In occasional

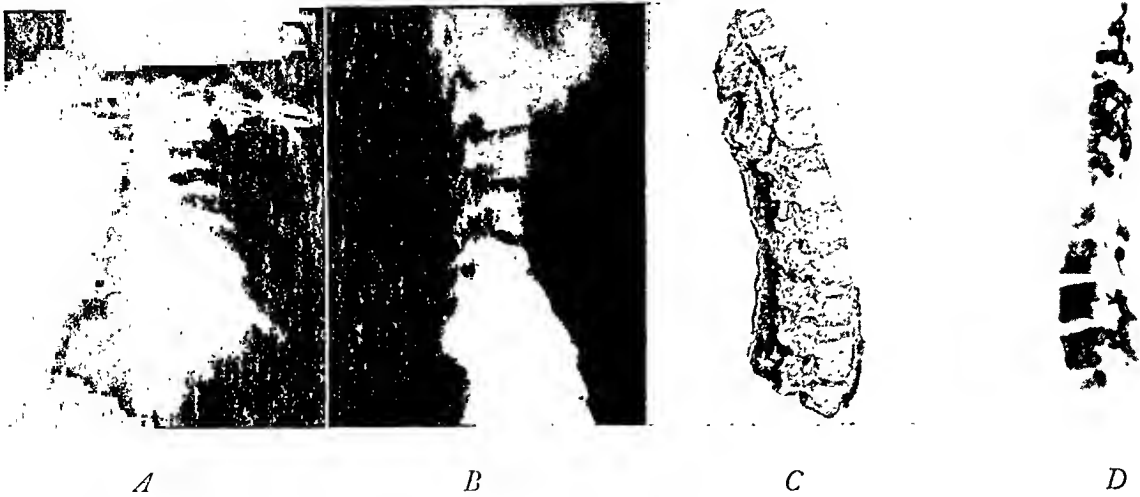


FIG. 2. Productive Pott's disease of all lumbar and lower six dorsal vertebrae. *A*, antemortem anteroposterior Potter-Bucky view. Large cold abscess; lipiodol injected into chest sinuses; no bone lesion demonstrable. *B*, lateral Potter-Bucky view of lumbar spine. No bone lesion demonstrable. *C*, postmortem photograph. Productive lesions in every vertebra, most marked in the lumbar region, minimal changes in the eleventh dorsal vertebra. *D*, postmortem lateral view of hemisection, same technique as Figure 1, *C*. "Sclerotic" areas in the bone correspond to the lesion seen grossly. The bone is denser in the lower lumbar vertebrae where the most extensive involvement is found.

areas where fragments of bony trabeculae are still present, the nuclei have lost their staining properties. At the periphery of the caseation is a zone of tuberculous granulation tissue composed of dilated capillaries, epithelioid and giant cells, fibroblasts and collagen fibers. This zone of granulation tissue erodes those bony trabeculae which it borders.

#### ROENTGENOLOGICAL INTERPRETATION

The roentgenographic appearance of the exudative (destructive) form of Pott's disease when the vertebral body is collapsed and the disc destroyed is too well known to bear repetition here. When the caseous process is limited to the central portion of the vertebrae or its small parts, the differential diagnosis may be confusing, since pyogenic or fungus infections can produce a similar picture. However, the general clinical appearance of the patient and study of the sinuses and fistulae which sometimes occur in the tuberculous and usually in the pyogenic infections can clarify the diagnosis. In any event, the roentgenologist can detect the destructive process even if he may not, from the roentgenogram alone, predict the etiology of the condition.

When, on the other hand, the disease in

the spine is an essentially productive one, it has been our experience that the possibility of its being diagnosed by the roentgenologist is remote indeed. Ninety-six of our 132 cases had had complete roentgenograms made of the spine within six months of death, usually within three months. These roentgenograms consisted of anteroposterior and lateral roentgenograms of the entire vertebral column from cervical to sacral regions. At necropsy in this group of 96, a total of 118 vertebrae or groups of vertebrae were found to have tuberculous lesions.

Seventy-five (63 per cent) of these were diagnosed correctly by the roentgenologist. In all of these cases the tuberculous process was a destructive one. In only 13 (11 per cent) instances did the roentgenograms fail to reveal destructive lesions. In 10 of them the roentgenograms were made more than three months before death and it is possible that at that time the process was either absent or too small to be roentgenographically demonstrable.

In contrast to this roentgenological accuracy, it is noted that not a single correct diagnosis was made in 30 (25 per cent) cases where the lesion was a productive one. In half of these, the roentgenographic

studies had been made within two months of death and in several cases within two weeks. One of these cases is particularly interesting (Fig. 2). The patient had an extensive "cold abscess" of the psoas muscles and paravertebral structures, which burrowed anteriorly beneath the ribs to the sternum. The abscess was diagnosed correctly ten months before death, but repeated complete spine roentgenograms, both at our own and other institutions, failed to reveal involvement of a single vertebral body. At necropsy every vertebra was diseased, some only partially, but the majority completely. Yet the intervertebral discs were intact and microscopic study of the bone revealed the trabeculae to be eroded but not destroyed, the caseation in the marrow spaces being more or less walled off by the productive elements. Obviously with the trabeculae intact there could be no collapse of the vertebrae or demonstration of areas of lessened density on the roentgenogram. This case was striking because of its extent; the other 29 cases with productive changes were qualitatively similar.

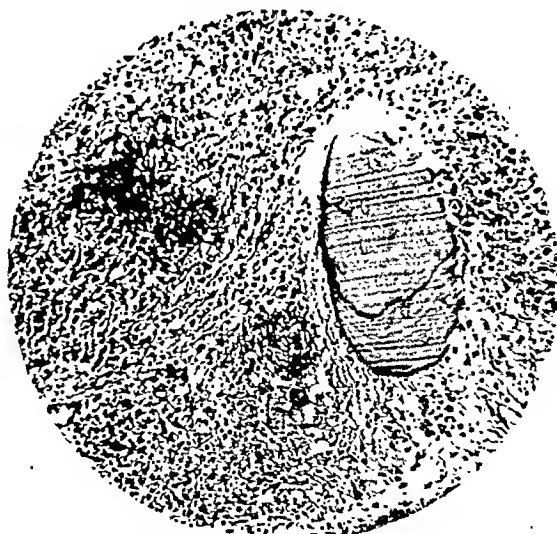
In an attempt to discover roentgeno-

graphic evidence which could be utilized to diagnose these productive changes before death, roentgenograms of hemisections of spines with this type of lesion were taken. Under these roentgenologically ideal conditions, one change persists—areas of increased density, corresponding exactly to the diseased areas noted grossly. These changes have been called "sclerotic," for want of a better term, although pathologically these areas are neither "hard" nor "indurated." The bone is of the same degree of firmness as that found normally, since the trabeculae themselves are essentially normal. Apparently, however, marrow spaces filled with granulation tissue and caseous material have less radiability than normal spaces filled with adipose tissue and hematopoietic elements.

With this thought in mind we reviewed the roentgenograms taken before death of the vertebrae showing productive changes. It is true that in only 2 were productive ("sclerotic") changes suggestive, perhaps because in an attempt to read only those findings which were actually present, our interpretations were too conservative. If,



*A*



*B*

FIG. 3. Photomicrographs of two forms of Pott's disease. *A*, section through a destructive area. The bone marrow which has become completely caseous has lost its nuclear stain. The bony trabeculae which are caseous have also lost their staining ability. *B*, section through a productive, "sclerotic," area. The tuberculous granulation tissue in the bone marrow completely surrounds intact bone. A Langhans giant cell lies within the granulation tissue.



however, postmortem roentgenograms can demonstrate definite roentgenographic changes, it should be possible, with awareness of the possibilities, to develop a technique and sufficient diagnostic acumen to detect these productive ("sclerotic") changes. It is perhaps too much to expect of the roentgenogram that, without other evidence of Pott's disease, "sclerotic" changes be considered diagnostic of the productive phase of that disease. Nevertheless, where other roentgenological evidence of vertebral tuberculosis exists the possibility of this type of lesion should be considered. Serial roentgenograms should be helpful by demonstrating changes in bone density as the productive lesion progresses.

The fact that both a predominantly productive ("sclerotic") and a predominantly exudative (destructive) disease may exist in different vertebrae in the same vertebral column should also be recognized. In 128 of our cases the type of lesion was described grossly as either one or the other and the impression confirmed by histological examination. In 80 (62 per cent) cases the disease was essentially exudative; in 15 (12 per cent) it was essentially productive, and in 33 (26 per cent) both types were found in about an equal number of vertebrae. It is important, then, for the roentgenologist, even when a destructive lesion is demonstrable, to scrutinize the entire spine carefully for evidence of additional "sclerotic" (productive) changes.

#### COMPLICATIONS

The complications of Pott's disease, especially those demonstrable roentgenographically, assume added significance when they furnish the only evidence that tuberculous involvement of the spine is present. This situation we have found to be not unusual when the vertebral disease is a productive one.

*Cold Abscess.* The "cold abscess" is so integral a part of Pott's disease that it is probably injudiciously called a complication. Roentgenologically this is important, since the abscess in spite or because of its

ramifications and burrowings readily lends itself to a roentgenographic diagnosis. Ornstein and Ulmar<sup>8</sup> have stressed the importance of the double contoured shadow of the paravertebral abscess and the advisability of complete studies of the spine on the basis of such a shadow, even without other evidence of Pott's disease.

Nathanson and Cohen,<sup>7</sup> in a study of 94 cases of Pott's disease, found roentgenologic evidence of an abscess in 60 per cent of their cases, in a number of which it was the only evidence of that disease. They pointed out, however, that paravertebral swellings were also present in other conditions, such as spinal cord tumors and could not, therefore, be said to be pathognomonic of tuberculosis without corroborating evidence.

One hundred and twenty-six (96 per cent) of our 132 cases were found to have "cold abscesses" at necropsy. In 2 of the remaining 6, fusion operations had been performed and the disease showed evidence of healing. The extent of the abscess varied, being limited, particularly in the dorsal region, to the involved vertebrae. On the other hand, small bony foci may produce large abscesses, while extensive vertebral disease may result in only small ones. The swelling is usually but not always bilateral. Whether the underlying bone involvement was a productive or exudative one had no relation to the size of the resulting abscess.

If they arise from a process in the lumbar vertebrae, the abscesses follow along the lateral sides of the vertebral column and thence into the sheath of the psoas muscle to form a psoas abscess. Such an abscess may also develop in a like manner from caries of the lower dorsal vertebrae. In following the course of blood vessels, a cold abscess may perforate the skin in multiple areas forming fistulous tracts. In 14 (10 per cent) of our cases the abscess perforated into the lung or pleura.

*Tuberculosis of the Ribs.* Tuberculous involvement of the ribs which is usually easily demonstrable roentgenologically may also furnish a clue to the presence of vertebral

disease. In 24 (18 per cent) of our cases of Pott's disease, one or more ribs were also involved. In some instances the discovery of the disease process in the rib focused attention on the vertebral column with ultimate discovery of a pathologic condition in the spine which had not previously been suspected. Admittedly the ribs may be involved without concomitant vertebral disease. This occurred in 11 (30 per cent) of 37 cases of tuberculosis of the ribs.

#### CONCLUSIONS

The pathology of two types of tuberculosis of the spine, exudative and productive, has been described and the roentgenological appearance of each noted. The importance of the productive form has been stressed, since such involvement even though extensive, may be impossible to detect roentgenographically. Increased density ("sclerosis") of the vertebral bodies in these cases has been suggested as of possible diagnostic significance, requiring further study. The importance of serial roentgenograms and an evaluation of the complications of Pott's disease have been described as of additional diagnostic aid.

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# "RING" SEQUESTRA AS A COMPLICATION OF FIXED SKELETAL TRACTION\*

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## REPORT OF CASES

THE introduction of skeletal traction revolutionized the treatment of fractures and since that time it has been very widely popularized. Its value in maintaining the position of fractures is well known but there are definite dangers associated with its use. Mathewson<sup>6</sup> gives an excellent discussion on the complications occurring with the use of skeletal traction. Haas<sup>2</sup> describes 3 instances of osteomyelitis in cases in which skeletal traction was employed. Killian,<sup>4</sup> Sarroste,<sup>7</sup> Lauber, Klapp and Siuts,<sup>5</sup> and Biebl,<sup>1</sup> also discuss osteomyelitis occurring in cases with skeletal traction.

A complication which occurs not uncommonly is the formation of "ring" sequestra, a condition frequently overlooked by the roentgenologist. I have been able to find very little reference to such a result in the literature. We have found 7 cases in our Orthopedic Clinic in the past two years. All the patients complained of pain about the Steinman pin through the upper tibia and all developed draining sinuses following the removal of the pins. Six of the patients were treated with pins incorporated in plaster casts which extended from the toes to above the knees with about 15 degrees flexion at the knees. They then became ambulatory and were seen in the out-patient clinic. Five of these 6 cases had pins inserted through the upper tibial fragment and the calcaneus. One case had a pin driven through the distal fragment as well as the proximal fragment. These 6 cases all had delayed union. The seventh patient was treated with the Kirschner wire extension. He had a fracture of the femur and humerus as well as the tibia and fibula. Non-union developed in both the femur and tibia necessitating bone grafts. A detailed description of each of the 7 cases follows.

CASE I. N. S., Negro, male, aged forty-two, was admitted for treatment of a compound fracture of the right tibia and fibula. Steinman pins were inserted through the upper third of the tibia and through the calcaneus on August 6, 1940. These were incorporated in a cast. The pins were removed on September 17, 1940, at which time slight drainage from the pin holes was noted and the patient complained of pain in the upper tibia. Roentgenograms taken after the removal of the cast and of the pins showed a ring of fairly dense bone immediately adjacent to the pin hole. The dense bone was surrounded by a zone of rarefaction giving the characteristic appearance of a "ring" sequestrum (Fig. 1). A sequestrectomy was done on September 28, 1940, at which time the temperature was normal and the leukocyte count was 9,950. The sequestrum was not entirely loose and had to be chiseled out. It was quite firm and had smooth outer margins. The discharge from the wound was profuse and continued to drain until March 6, 1941, at which time the sinus tract was completely healed. On March 20, 1941, the patient was walking with a cane and roentgenograms showed considerable callus formation at the fracture lines. The site of the sequestrectomy was also noted to be filling in with new bone. The patient was last seen on April 10, 1941, at which time there was good union and the patient had no symptoms.

CASE II. F. G., a white male, aged twenty-six, admitted to the hospital on March 12, 1941, with a compound fracture of the left tibia and fibula. Steinman pins were inserted through the upper third of the tibia and calcaneus. The patient complained of a great deal of pain in upper tibia and on April 10, 1941, the pins were removed. There was considerable drainage from the pin holes and roentgenograms revealed a definite "ring" sequestrum (Fig. 2). The temperature at this time was 99° F. and the leukocyte count was 11,800. A sequestrectomy was done on April 24, 1941, and a perfectly round piece of bone with the pin hole in the center was

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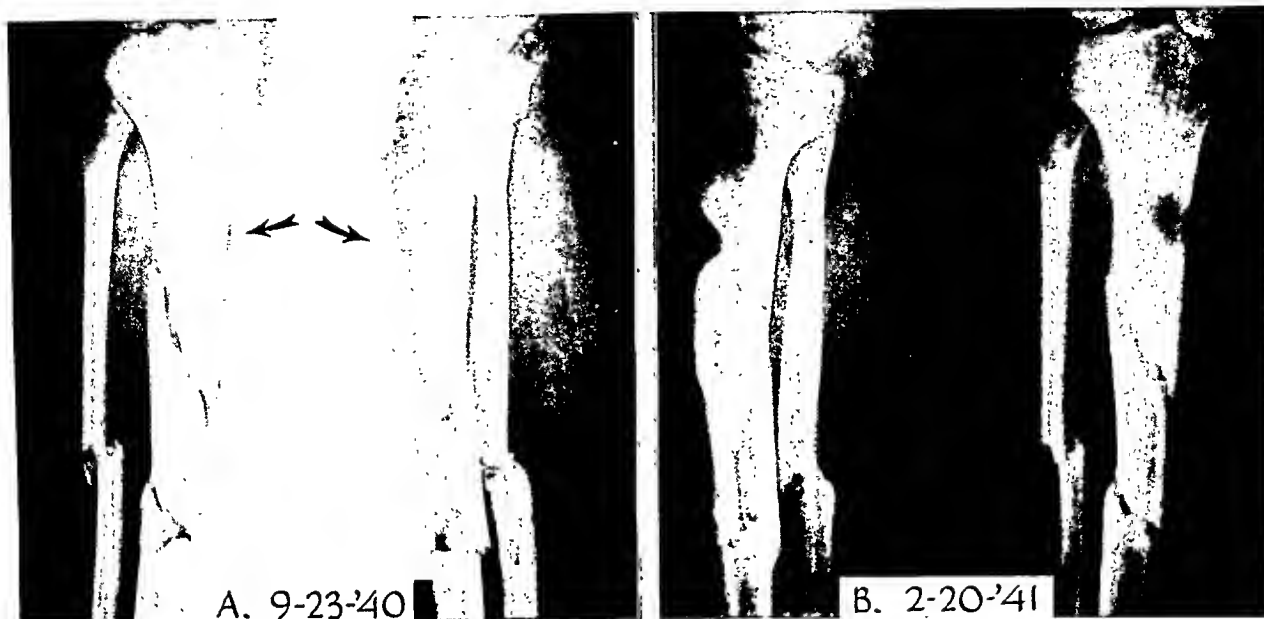


FIG. 1. Case I. Steinman pins were put through upper fragment of tibia and calcaneus. Pins were in position for forty-two days. *A* shows the "ring" sequestrum with the density about the pin hole which is in turn surrounded by a zone of rarefaction. *B*, roentgenogram on February 20, 1941, showing some periosteal proliferation and filling in of new bone. Note also the callus formation about the fracture sites. Patient was last seen on April 10, 1941, at which time he was walking without any difficulty. Unfortunately a roentgenogram was not made at this time.

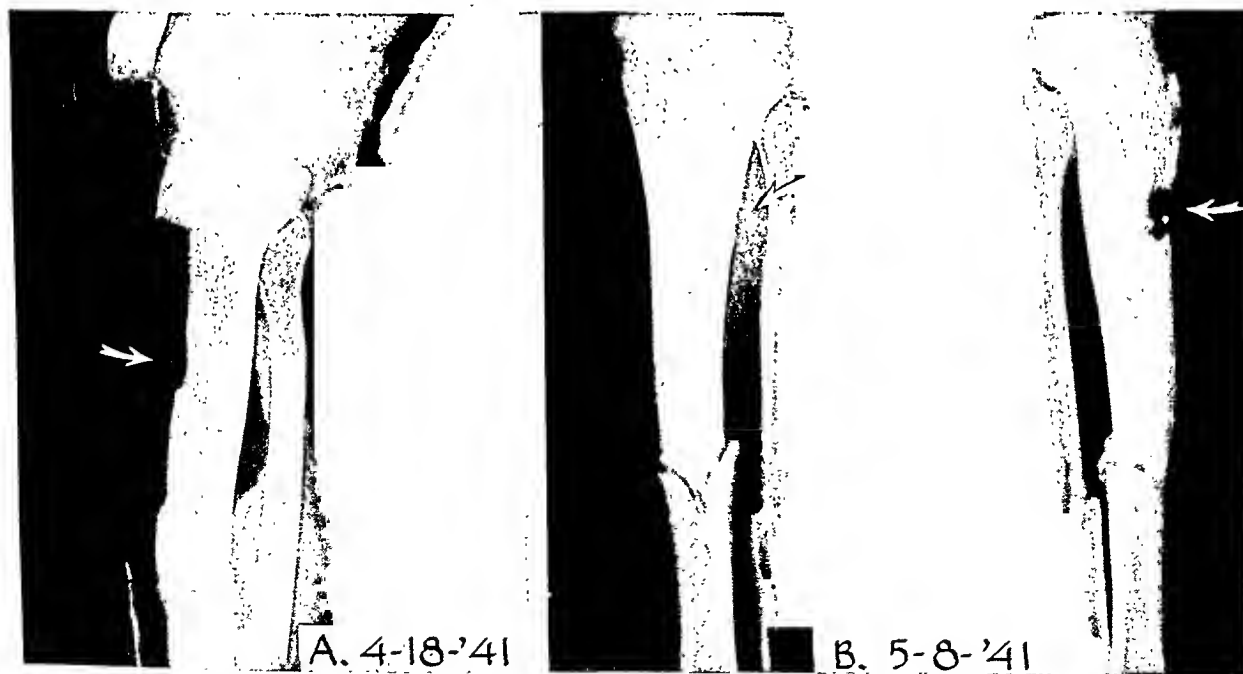


FIG. 2. Case II. *A* shows the typical "ring" sequestrum with fairly marked resorption of bone around the sequestrum. *B* shows the appearance after removal. The sequestrum was removed through the medial aspect of tibia by following the draining sinus. Note that some pieces of the sequestrum were left in the soft tissues.

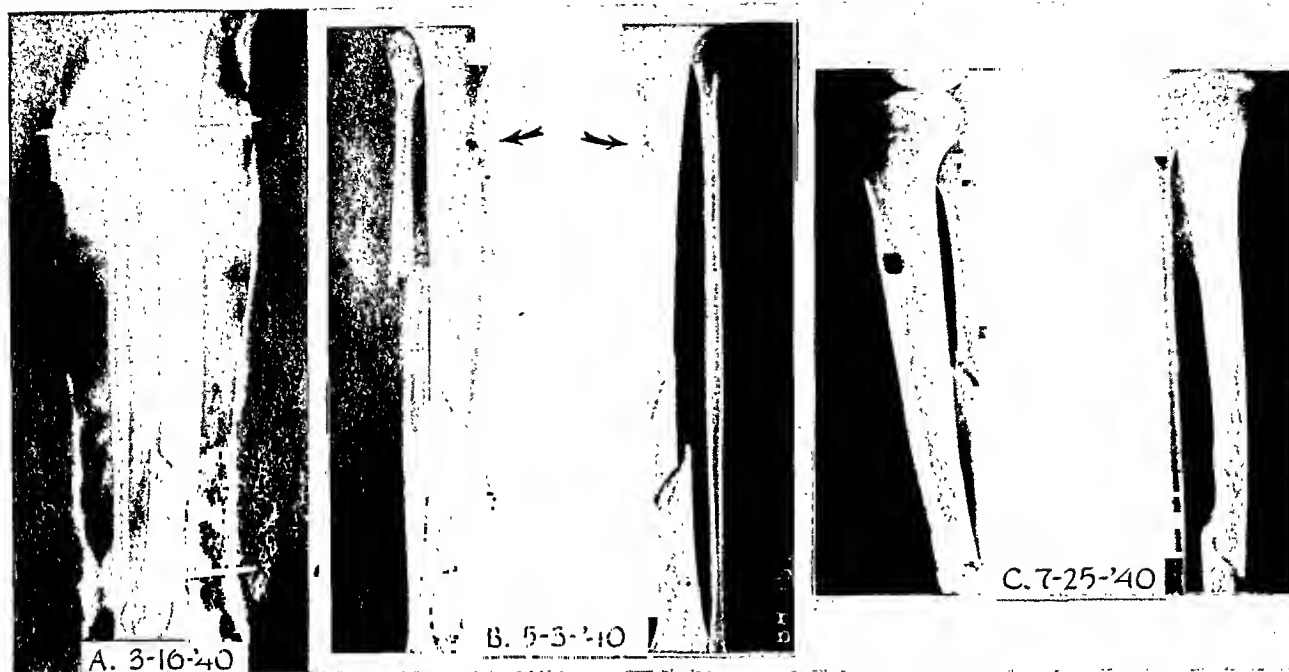


FIG. 3. Case III. *A*, pins in position. *B*, "ring" sequestrum about the upper pin hole. The normal appearing pin hole is seen in the distal fragment. Note that there is no evidence of a "ring" sequestrum in this region. *C*, after sequestrectomy.

removed. The sequestrum was lying loose in a pocket with pus about it. The bone was again noted to be firm and with a smooth outer margin. Cultures showed *Staphylococcus aureus*. Roentgenograms made on May 8, 1941, showed several loose bone fragments in the soft tissues.

There was still a large amount of drainage from the sinus tract. No further follow up was obtained.

CASE III. J. W., Negro, male, aged twenty-three, was admitted to the hospital with comminuted fractures of the right tibia and fibula

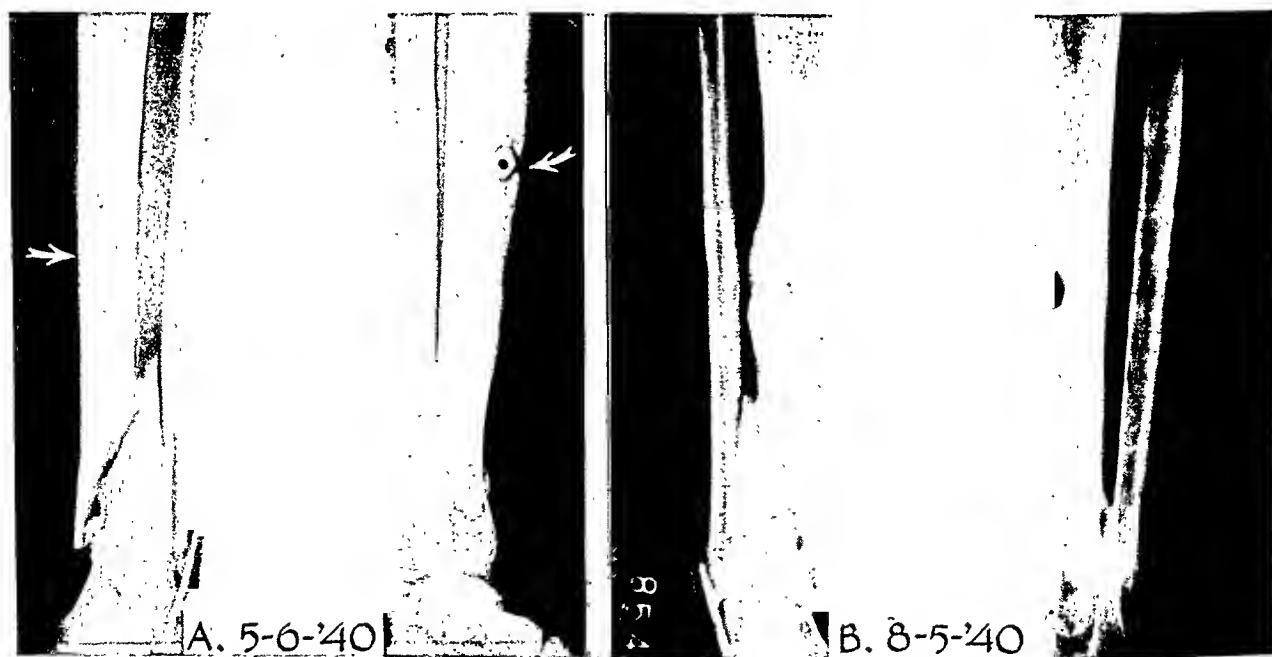


FIG. 4. Case v. *A*, characteristic "ring" sequestrum with rarefaction about it. *B*, appearance after removal of sequestrum. The piece of bone was lying loose in pus.

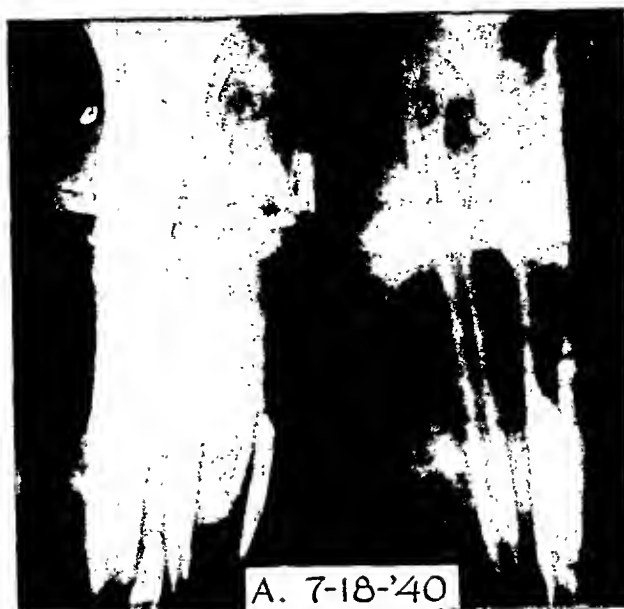


FIG. 5. Case VI. *A*, roentgenogram of leg in plaster exhibits a "ring" sequestrum. *B*, roentgenogram about one month after sequestrectomy. *C*, roentgenogram on July 5, 1941, shows that the fracture is united and that there is filling in of bone at the site of the sequestrectomy. All of the roentgenograms reveal an old osteomyelitis of the upper end of the tibia which followed a gunshot wound several years before the present admission.

on March 16, 1940, at which time Steinman pins were put through the upper and lower fragments of the tibia and incorporated in plaster. The patient was then discharged from the hospital and treated in the out-patient clinic. The pins were removed on May 3, 1940. There was some drainage from the upper pin holes associated with pain. Roentgenograms re-

vealed a typical "ring" sequestrum (Fig. 3). A sequestrectomy was done on July 8, 1940, the procedure being carried out along the path of the draining sinus. The temperature was normal. The patient returned at frequent intervals for dressings and on August 1, 1940, only a small amount of drainage remained. Good union of the fracture was obtained.



FIG. 6. Case VII. Roentgenogram reveals a "ring" sequestrum showing the same typical appearance.

CASE IV. E. H., a white male, aged forty, was admitted with fractures of the left femur, left tibia and left humerus on November 6, 1939. Kirschner wires were put through the lower end of the femur, lower portion of the upper fragment of the tibia and through the lower fragment of the tibia. An additional wire was later put through the loose middle fragment. These wires were left in place until November 16, 1939, at which time they were removed. Roentgenograms made later showed a small ring sequestrum which is not as clearly demonstrated as those occurring with the use of Steinman pins. Non-union of the fractured femur and the tibia and fibula resulted and bone grafts were done.

CASE V. F. G., a white male, aged forty-one, was admitted on February 5, 1940, with comminuted fractures of the tibia and fibula. Steinman pins were inserted through the upper tibial fragment and the calcaneus on the following day. The case was followed in the out-patient clinic. The upper pin became loose and painful so that pins were removed eleven days after their insertion. The patient's temperature was normal but there was drainage through the pin holes. This sinus continued to drain and frequent dressings were applied. Roentgenograms on May 9, 1940, revealed a "ring" sequestrum (Fig. 4). The leukocyte count was 10,000 and there was a slight elevation of temperature on July 12, 1940, at which time a sequestrectomy was performed. Considerable pus was obtained and a circular, firm sequestrum was found lying in a cavity filled with pus.

CASE VI. J. M., a white male, aged forty, was admitted to the hospital on May 19, 1940, with an oblique fracture through the left tibia and fibula. There was also evidence of an old osteomyelitis of the upper end of the tibia as a result of a gunshot wound. There was no activity present. Steinman pins were inserted through the upper end of the tibia and the calcaneus and immobilized in a plaster cast. The patient complained of pain about the upper pin and both pins were removed on June 6, 1940. There was some purulent drainage from the pin holes. Roentgenograms made on July 18, 1940, showed the characteristic "ring" sequestrum (Fig. 5). A circular, firm sequestrum was removed on July 23, 1940, considerable pus was present and the pain was relieved. The patient returned to the clinic on several occasions at which time the wound was dressed. The sinus was healed on December 5, 1940. The patient was walking with a cane four months later.

CASE VII. C. S., a white male, aged twenty-nine, was admitted on March 6, 1941, with a fracture of the tibia and fibula of the right leg, at which time Steinman pins were inserted through the upper tibia and calcaneus and a cast applied. The patient complained of pain about the upper pin and on April 6, 1941, the pins were removed. A draining sinus developed from the pin holes. The patient was seen in the clinic on several occasions and the dressings over the sinuses were changed. Roentgenograms made on April 12, 1941, revealed a "ring" sequestrum. The patient refused an operation and came to the clinic for dressings until July 21, 1941, at which time he left town. No further follow up was available.

#### DISCUSSION

How do the "ring" sequestra described above come about and what is their importance? Infection is probably the chief factor as it is the greatest hazard associated with the introduction of a metal pin into bone. After the pin has been in place for a short time there is some resorption of bone immediately adjacent to it which allows movement of the pin on its long axis. Motion on the part of the patient then enables bacteria to be carried from the skin to the subcutaneous tissues and subsequently into the bone itself. Infection may thus start on



the skin and extend along the pin by direct continuity. This, we believe, is the source of the infection in the production of "ring" sequestra. One might expect the bone destruction to begin immediately adjacent to the pin but this is not the case. As shown in Figures 1, 2, 3, 4, 5 and 6 there is a hole, made by the introduction of the pin, surrounded by a zone of bone, which in turn is surrounded by an area of rarefaction. The ring of bone appears slightly more dense on the roentgenogram than does the surrounding bone. This may be explained by the fact that the surrounding bone still has its blood supply and has become atrophic from disuse, while the sequestrum has lost its blood supply and would therefore maintain its normal amount of calcium.<sup>3</sup>

It is instructive to note that all of our cases developed "ring" sequestra about the pin through the upper part of the tibia. At this site there is more motion of the pin and more stress is placed upon the bone. We know from the cultures that bacteria and pus are present, yet the destruction does not occur immediately adjacent to the pin which one would expect if infection were the only factor. The bone about the pin hole also appears more dense on the roentgenograms giving an appearance similar to that seen in aseptic necrosis. This evidence indicates that "ring" sequestra are probably the result of two factors—pressure necrosis and infection.

Mathewson<sup>6</sup> discusses the dangers of continued skeletal traction in cases which develop osteomyelitis. He gives illustrations of extensive bone destruction and migration of the pin from the bone into the adjacent soft tissues. Fortunately, the patients usually have considerable pain which calls attention to the complication. Most of our cases had no elevation of temperature and only 2 showed an increase in the white blood cell count. It is important to make the diagnosis of "ring" sequestra early in order to prevent further complications. Five of our cases were operated upon and had filling in of new bone at the site of the sequestrectomy, while their draining

sinuses healed completely. Two of the cases did not have a sequestrectomy performed and still had draining sinuses at the time of the last observation. The infection is apparently of low grade so that the typical roentgenological appearance of an osteomyelitis does not develop.

#### SUMMARY AND CONCLUSION

1. Seven cases of "ring" sequestra developing in the upper end of the tibia following fixed skeletal traction with pins incorporated in a plaster cast are reported.
2. In six of these cases Steinman pins were used; in one a Kirschner wire.
3. Roentgenologists should give special attention to the observation of such cases as the diagnosis will depend entirely upon the roentgen examination.
4. It is important to make the diagnosis as soon as possible so that the skeletal traction may be removed.
5. Constant traction under these conditions may lead to extensive bone damage or to migration of the pin out of the bone into soft tissues, epiphyses or joints.
6. The etiology is probably pressure necrosis plus a low grade infection.

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# OSTEOID-OSTEOMA

## A REVIEW OF PORTIONS OF THE LITERATURE AND PRESENTATION OF CASES

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ALTHOUGH Jaffe's original article<sup>1</sup> on osteoid-osteoma appeared in 1935, it was only with the later article by Jaffe and Lichtenstein<sup>2</sup> in 1940, and with the presentation of the subject at that time by them and their colleagues at medical meetings, that knowledge of this interesting and important condition began to spread. Because of the likelihood that not all roentgenologists are yet familiar with osteoid-osteoma, this brief review of the paper by Jaffe and Lichtenstein and this small group of cases are presented.

Jaffe and Lichtenstein<sup>2</sup> reported 33 cases, more often in males, most frequently in youth, with rather wide skeletal distribution exclusive of ribs, innominate bones, and skull. History of antecedent relevant trauma was not common. Pain was the chief symptom, often mild at the onset, but becoming increasingly severe, and frequently interfering with sleep. Local swelling was a less constant complaint. Limp, stiffness, and weakness were present in some cases.

Findings on physical examination included swelling, local tenderness, limp, and sometimes atrophy. Local heat and redness, with history of fever, were notably absent.

The lesion, as they describe it, consists of a small, benign, slowly growing osteogenic tumor. In its early stages it is composed largely of osteoid tissue. Subsequently the osteoid becomes calcified and converted into hypercalcified atypical bone. They note, however, that there is no clear-cut correspondence between the age of the lesion, as represented by the patient's complaint, and the gross and microscopic ob-

servations. An outstanding characteristic of this tumor is the excessive perifocal reactive response it produces in the surrounding bone. An osteoid-osteoma arising in spongy bone is usually surrounded by a narrow zone of vascular connective tissue, which in turn is usually surrounded by a zone of sclerotic osseous tissue. Microscopic examination fails to reveal any infectious inflammatory basis for the sclerosis. When arising in cortical bone, presumably because of periosteal irritation, the deposition of sclerotic new bone is very great. When superficially located, the tumor often abuts upon, and even erodes, the overlying cortical shell. It may then elevate the periosteum, but does not penetrate the latter, and may not even stimulate it to excessive formation of bone.

With regard to the clinical diagnosis, Jaffe and Lichtenstein feel that this is really not very difficult, and that one should suspect it when the patient is an adolescent or young adult, with a well localized bone pain of at least some months' duration, with absence of fever and local heat, though some local swelling may be present. Clinical laboratory findings shed no light on the cases, but the roentgenographic appearance constitutes the most valuable single diagnostic guide. In the early stages of the tumor evolution, it appears as a roundish radiolucent or rarefied area from 5 mm. to 2 cm. in diameter. Later in its evolution, as it tends to become calcified and ossified, it may present an opacity. This opacity may, nevertheless, be made to stand out from the neighboring opaque bone by a narrow zone which is more permeable to the roentgen rays. Early



FIG. 1. Case 1. Clinically and roentgenologically a typical case of osteoid-osteoma, arising superficially against the neck of the femur, showing a partially ossified nidus, with erosion of the cortical shell, with elevation of the periosteum, without production of perifocal bone reaction. Not proved pathologically, probably because of our inexperience with osteoid-osteoma at that time.

and late in its evolution, the tumor, or nidus, is surrounded by the reactively changed surrounding tissue. This appears as a more or less opaque or dense zone. This dense area, in spongiosa, may be only a narrow ring, or it may spread for several centimeters about the lesion. In cortical bone, it may extend for several inches above and below the osteoid-osteoma proper, and for a considerable distance around the circumference of the affected shaft.

In some instances, Jaffe and Lichtenstein report, when the tumor is located in the shaft cortex of a long bone, it is difficult or impossible to trace out the opaque nidus representing the ossified osteoid-osteoma from the surrounding reactively thickened and densified cortical bone. Dr. M. M. Pomeranz, Roentgenologist of the Hospital for Joint Diseases, has shown that, under these conditions, overexposing the film and taking the roentgenogram in various planes with a cone may enable one to recognize the lesion more readily.

In differential diagnosis the authors find that these lesions are most often mistaken for bone abscess and chronic osteomyelitis. They are commonly mislabeled "chronic

sclerosing non-suppurative osteomyelitis," or intracortical abscess with inflamed bone around it. The lesions have occasionally been diagnosed syphilitic osteoperiostitis, or even sclerosing osteogenic sarcoma.

It has been our privilege at the Hospital for Special Surgery to study 11 cases of osteoid-osteoma, 9 proved, and 2 which fall beyond reasonable doubt into this classification. Clinically, roentgenologically, and pathologically our cases have conformed to the descriptions and criteria of Jaffe and Lichtenstein; and perhaps our only original contribution is the recording of a case occurring in an innominate bone.

#### CASE REPORTS

Case 1. J. S., male, aged twenty. First seen August 23, 1939, with a history that sixteen months before, two weeks after a very minor injury, he began to have pain behind the left greater trochanter. This has persisted. He has been seen by many physicians, and has had much treatment without relief.

Examination showed tenderness over the femoral neck, limited hip motion, 3 cm. atrophy of the thigh.

A roentgenogram (Fig. 1) showed a lesion in the femoral neck, believed at that time suspicious of a small bone abscess. Roentgen ex-



FIG. 2. Case II. Proved case of osteoid-osteoma, arising superficially near the adductor tubercle. Nidus clearly visible, and extensive perifocal bone reaction.

aminations November 16, 1939, and February 2, 1940, showed no definite change in the appearance. Dr. Ramsay Spillman, who interpreted the last roentgenograms, suggested as a diagnosis either a very low grade bone abscess or osteoid-osteoma.

An operation was performed on February 5, 1940. Roentgen examination on February 20, 1940, showed that the pathological area in the femoral neck had been widely excised.

Although the report of the pathologist was chronic inflammation, there seems little room for doubt from the clinical course and the roentgen findings that we were dealing with an osteoid-osteoma, which we did not succeed in confirming pathologically due to our inexperience with this condition at that time, this being our first case.

The patient made a good recovery and has been relieved of his pain.

Case II. C. A., male, aged twenty. The patient came to the clinic on November 19, 1940, with a complaint of pain in the knee of six months' duration. He had received diathermy from a private physician without relief.

Examination showed a tender area about the adductor tubercle, with inability to flex the knee completely.

Roentgen examination on November 28, 1940 (Fig. 2) showed a rather orderly subperiosteal

Roentgen examination of the right leg on that day (Fig. 3) showed a zone of density in the upper third of the tibial shaft, measuring about 7 cm. in length. There was subperiosteal deposition of lime on the tibia at this level, mostly posteriorly; and near the posterior cortex was a rather sharply defined zone of rarefaction. The findings suggested a bone abscess or osteoid-osteoma.

At operation on September 12, 1941, a block



FIG. 3. Case III. Proved case of osteoid-osteoma, arising in the posterior cortex, and producing extensive perifocal reactive response in the surrounding bone. *Right*, roentgenogram of excised block of bone, demonstrating that the nidus has been removed.

deposition of lime slightly above the adductor tubercle, with a rather sharply defined rounded rarefaction just below the new lime. Osteoid-osteoma was suggested as a possible diagnosis.

The bony mass was removed at operation on November 29, 1940. Report of the pathologist: osteoid-osteoma.

Recovery and postoperative course were very satisfactory. Although a considerable mass of amorphous lime formed in the operative area, the patient has remained symptom free with a full range of motion in the knee.

Case III. M. DeC., female, aged nineteen, came to the clinic August 19, 1941, with complaint of pain and swelling at the back of the leg of twelve months' duration.

of bone was removed from the pathological area. Roentgen examination of the excised specimen (Fig. 3) showed that the nidus had been removed. The pathologist reported osteoid-osteoma.

The recovery was uneventful, and the patient was found symptom free at the follow-up on May 11, 1942.

CASE IV. A. G., male, aged fifteen, came to the clinic September 4, 1941, with a history of having been struck by an automobile while riding a bicycle on March 16, 1941. Two months after this he began to "walk crooked" and complained of pain in the mid-back region. He cried out with pain at night, and had lost about 22 pounds in weight.



FIG. 4. Case iv. Proved case of osteoid-osteoma, arising from the right small posterior articulation between the tenth and eleventh dorsal vertebrae. Nidus and surrounding reactive sclerotic bone shown.

Examination showed a thin, undernourished boy, standing with a marked list to the left, with a left dorsal right lumbar scoliosis. Forward bending was impossible because of pain; lateral bending was restricted. There was tenderness over the lower dorsal spine, with marked muscle spasm.

Several roentgen examinations in September, 1941 (Fig. 4) revealed the list and scoliosis, and showed a moderately large deposit of lime related to the right small posterior articulation between the tenth and eleventh dorsal vertebrae.

Roentgen and clinical diagnoses were various and incorrect. A biopsy was done on an enlarged axillary node, with histopathological report of hyperplasia.

At operation on the spine October 1, 1941, a bony mass about 1 inch in diameter was found, and as much as possible was removed. The report of the pathologist was osteoid-osteoma.

The patient did not improve appreciably after the operation, and was treated at the Seaside Hospital branch for a number of months, but there was a gradual increase in the severity of the symptoms. Further roentgenograms showed that the calcareous deposit was still present, or had recurred.

A second operation was performed August 12, 1942, with removal of the bony mass. Report of the pathologist was osteoid-osteoma. Following this operation the patient made an excellent recovery, and was found symptom free and with normal mobility of the spine on June 7, 1943.

CASE V. M.B., male, aged twelve and a half, was brought to the clinic October 23, 1941, because of pain in the right thigh and night cries, duration more than two years. He had been studied at another hospital without positive findings.

Examination showed right-sided limp, limited forward bending, 5° flexion contracture of the right knee, 1 cm. atrophy of the thigh, and 0.5 cm. atrophy of the calf. There was limited straight leg raising on the right.

Roentgen examination (Fig. 5) showed an area of increased density in the right ilium adjacent to the sacroiliac joint, extending forward along the brim of the true pelvis. There was a list of the lumbar spine toward the right.

By January 5, 1942, the patient was definitely worse. Roentgen examination at that time showed more scoliosis, and more tilt and rotation of the pelvis. The zone of sclerosis in the right iliac bone was present, with a small rounded area of rarefaction near the lower angle of the sacroiliac joint. The possibility of osteoid-osteoma was suggested.

At operation February 11, 1942, a block of bone was removed from the right ilium. A roentgenogram on February 14, 1942, showed that all the abnormal looking bone had been removed. Roentgenogram of the excised specimen (Fig. 5) showed that the nidus had been removed. The report of the pathologist was osteoid-osteoma.

Convalescence was uneventful with the patient free from pain. The follow-up note on June 21, 1943, reported: He walks without a limp, has no list. Has no complaints. There are no abnormal findings. Has been engaging in normal activities.

CASE VI. B.G., male, aged fourteen and a half, came to the clinic February 14, 1942, with



FIG. 5. Case v. Dumb-bell shaped lesion in the right ilium, with partially ossified nidus, with extensive sclerotic reaction in the surrounding bone. *Right*, roentgenogram of excised bone, showing the nidus. Proved case of osteoid-osteoma.



FIG. 6. Case vi. Partially ossified osteoid-osteoma, lying in an eroded depression in the anterior cortex, and producing marked reaction in the adjacent portions of bones. Proved case.

complaint of swelling of the left index finger. He had injured this finger while playing baseball six months before. He had been seen at another hospital where amputation was advised.

Examination showed a fusiform swelling of the finger.

Roentgen examination February 14, 1942 (Fig. 6) showed an old deformity at the junction of the shaft and head of the proximal phalanx, suggestive of an old oblique fracture without gross displacement. There was noted a curious smooth indentation on the anterior surface of

mal phalanx. This was taken proximally, and did not include the lesion near the head of the bone. Report on the excised tissue: reactive sclerosing osteitis.

A second operation was performed on March 21, 1942, and the lesion near the distal end of the phalanx was removed. Report of the pathologist: periosteal osteoid-osteoma.

The patient was seen at the end-result clinic June 28, 1943. He had no complaints, and had only 5° limitation in active and passive extension of the proximal interphalangeal joint. The residual deformity of his finger was slight.

CASE VII. W.A., male, aged thirteen and a half, came to the clinic July 9, 1942, with complaint of pain along the anterolateral aspect of the right leg, just below the knee. Duration about two years, ever since he received a laceration from a spike just below the upper extremity of the fibula. The pain has been worse at night, but was sufficient to cause a limp during the daytime.

On examination, tenderness to deep pressure was elicited over the upper third of the tibial shaft.

Roentgen examination July 16 and 23, 1942 (Fig. 7) showed an old smooth enlargement of the posterior and lateral portions of the shaft of the tibia, at about the junction of the upper and middle thirds. The area of enlargement showed a homogeneous increase in density. Detail roentgenograms of considerable density failed to show any nidus or central softening. The condition was thought to be osteoid-osteoma or small cortical abscess. At operation July 29, 1942, a large block of bone was removed. In the specimen the pathologist found a very small nidus, and histopathologically the characteristic findings of osteoid-osteoma were present.

Convalescence was uneventful. He was seen about six weeks after operation, and had no complaints at that time.

CASE VIII. A.L., male, aged twenty-one, came to the clinic August 31, 1942, with complaint of pain along the anteromedial aspect of the left thigh for two or three months. The pain was worse at night, leaving him very stiff in the morning. There was no history of injury. The symptoms have been present every day, and he has not been improving.

Examination showed 1 inch atrophy of the left thigh, and no other findings.



FIG. 7. Case VII. Perifocal reactive response in tibia. The nidus could not be demonstrated even in detail roentgenograms of considerable density. Diagnosed preoperatively as osteoid-osteoma; diagnosis confirmed by pathologist.

the head of this phalanx, suggestive of pressure atrophy. This indentation contained a smoothly rounded bony body. A very large deposition of new bone all about the shaft of this proximal phalanx was noted, and much thickening of the surrounding soft tissues. There was no definite evidence of joint involvement. There was some roughening and thickening of the cortex of the middle phalanx. The diagnosis was uncertain, but dactylitis of some type, or osteoid-osteoma, was mentioned as a possibility.

At operation February 25, 1942, a block of bone was removed from the shaft of the proxi-

Roentgen examination (Fig. 8) showed a local orderly deposition of subperiosteal new bone along the posteromedial aspect of the femoral shaft in its middle third, for a distance of about 8 cm. In the center of the new bone formation was a small, sharply defined, oval rarefaction.

The history and findings seemed entirely characteristic of osteoid-osteoma.

The patient did not return for operation, so the diagnosis remains unproved.

CASE IX. G.DeC., female, aged three, was brought to the clinic September 23, 1942, because of painful swelling of the right leg, present since January, 1941. A previous biopsy at another hospital was said by the mother to have been reported "inflammation." There was no history of injury; there has never been drainage, the pain has been worse at night causing night cries.

In the right leg about 2 inches below the knee was found a swelling about 9 by 5 cm., with a well healed scar.

Roentgen examination on October 22, 1942 (Fig. 9) showed old anterior and medial bowing



FIG. 8. Case VIII. History, physical examination, and roentgenogram entirely characteristic of osteoid-osteoma. The patient did not come in for operation, so the case remains unproved.

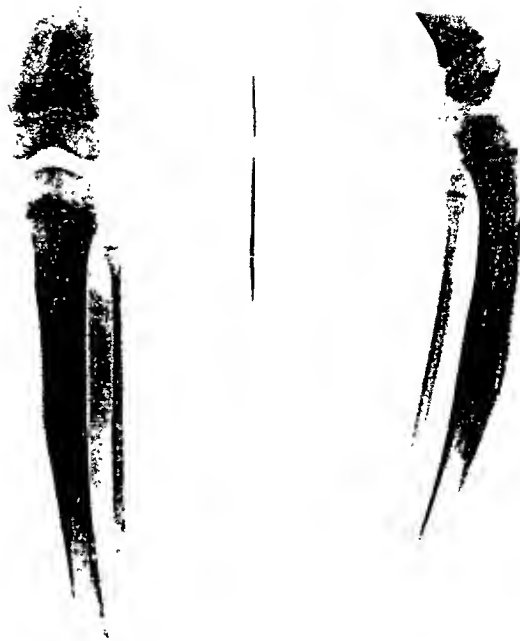


FIG. 9. Case IX. A previous operation elsewhere was said by the mother to show "inflammation." The preoperative provisional diagnosis in our hospital, based on the clinical findings and the above roentgenogram, was chronic osteomyelitis, or possibly osteoid-osteoma. Report of pathologist: osteoid-osteoma. There was recurrence of symptoms six months after our operation, at which time the roentgenogram showed either a residual or recurrent nidus. The patient is under observation at the present time.

of the tibia, with overgrowth of this bone as compared with the fibula. There was old thickening of the tibial cortices in the upper and middle thirds, with a central and medial rarefaction which might be the result of the old biopsy. Moderate swelling and thickening of the overlying soft tissues was noted. The findings were thought suggestive of old osteomyelitis. Osteoid-osteoma seemed less likely, and Ewing's tumor very unlikely.

At operation on October 28, 1942, a flap of bone was removed, the lesion was curetted, and the wound closed.

Report of the pathologist: osteoid-osteoma.

The recovery was good, and the patient was symptom free for about six months. Since then there has been recurrence of pain and swelling, and roentgen examination showed a centrally placed, sharply defined, rounded rarefaction strongly suggestive of residual or recurrent nidus. The patient is under observation at the present time.





FIG. 10. Case x. Proved case. Osteoid-osteoma near the anterior cortex, with rather moderate reaction in the surrounding bone.



FIG. 11. Case x1. Typical case of osteoid-osteoma clinically, by roentgen examination and pathologically.

CASE x. C.W., male, aged twenty-three months, was brought to the clinic April 5, 1943, with symptoms of weakness of the left arm. He was seen in consultation in the pediatrics clinic, and was treated with physiotherapy. Because of his failure to improve, roentgenograms were taken April 22 and 26 (Fig. 10), showing in, or close to, the anteromedial cortex of the humeral shaft in its middle third a small rounded zone of rarefaction, with parallel layers of subperiosteal lime laid down anterior to it. Osteoid-osteoma or small bone abscess was suggested as a possible diagnosis.

At operation May 12, 1943, the abnormal bone was removed. Roentgen examination of the excised specimen showed that the nidus had been included.

Report of the pathologist: osteoid-osteoma.

Recovery was uneventful. The patient was seen in the clinic June 24, 1943, at which time there were no symptoms, and there was free use of the extremity.

CASE x1. C.O., female, aged sixteen, was sent into the hospital July 28, 1943, by Dr. Richmond Stephens, with a diagnosis of osteoid-osteoma. There was a ten months' history of pain in the right leg, just below the knee, gradual in onset, aching in character. No preceding injury.

Examination showed some atrophy of the thigh and leg, with no other findings.

Roentgen examination on July 28, 1943 (Fig. 11) showed, in the lateral cortex of the upper third of the right tibial shaft, a small rarefaction surrounded by a considerable zone of sclerosis, with subperiosteal new bone formation on the lateral surface of the bone. The appearance seemed entirely characteristic of osteoid-osteoma.

Operation on July 29, 1943, removed a block of bone from the pathological area. Roentgenogram of the excised specimen showed that the nidus was included. Report of the pathologist was osteoid-osteoma. The convalescence was uneventful.

#### SUMMARY AND CONCLUSIONS

1. Jaffe and Lichtenstein's recent article on osteoid-osteoma has been reviewed.

2. Nine proved and two probable cases of this condition are presented.

3. Clinically, roentgenologically, and pathologically our cases have conformed to the descriptions and criteria of Jaffe and Lichtenstein.

4. Simple removal of the osteoid-osteoma (the nidus) apparently brings prompt cure. Removal of all the perifocal bone reaction is probably unnecessary. Failure to remove the nidus results in persistence of symptoms.

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# PANCREATIC CYST AND LITHIASIS

## CLASSIFICATION AND INCIDENCE; REPORT OF A PSEUDOCYST ASSOCIATED WITH DISSEMINATED PARENCHYMAL CALCIFICATION

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RECENT years have witnessed an increased interest in diseases of the pancreas resulting in new surgical, biochemical and roentgenographic techniques. The developments from the roentgenological aspect have been well summarized by Case in his splendid paper delivered as the twentieth Caldwell Lecture. The occurrence of a cyst and calculi in the pancreas of a patient stimulated a review of the etiology and incidence; interest was especially centered on any possible relation between the two lesions.

Cysts are classified as true if an inner-wall lining epithelium is present; and false, if not. This general division, however, is seldom of practical use, since in the majority of cysts this differentiation is histopathologically impossible. Anatomically, cysts are either intraparenchymal or extraparenchymal, depending upon the degree of investment by parenchyma. Again, this difference is of importance only in the operating room, since it can rarely be determined preoperatively. The following outline has been compiled from the classifications of Gross and Gulecke, Moynihan, and Mayo-Robson, Barron, and Mahorner and Mattson. To it has been added cystic fibrosis of the pancreas, a disease entity described in detail relatively recently by Andersen.

### TRUE CYSTS

- A. Congenital
  - 1. In infants
    - a. Cystic fibrosis
    - b. Simple or multiple cysts
  - 2. Dysontogenetic
- B. Retention

### C. Neoplastic

- 1. Proliferative
  - a. Cyst—adenoma
  - b. Cyst—squamous epithelioma
  - c. Cyst—adenocarcinoma
- 2. Embryonal
  - a. Dermoid or teratomatous cysts
  - b. Inclusion cysts

### FALSE CYSTS

#### A. Traumatic (pseudocysts)

- 1. Hemorrhagic
- 2. Apoplectic

#### B. Inflammatory

#### C. Degenerative

#### D. Parasitic

- 1. Echinococcus (hydatid)
- 2. Cysticercus cellulosae

### INCIDENCE OF CYSTS

Cysts are very rare. Table I reveals an average incidence of 0.061 per cent from

TABLE I  
INCIDENCE OF CYST FROM NECROPSY STUDIES

Authors	Necropsies	Cysts
Mayo-Robson	6,708	3
Barron	3,437	1
Guy's Hospital (Hawes)	6,000	4
McClure and Jankelson (Portis)	13,342	10
Total	29,487	18
	Per cent 0.061	

necropsy figures. Mahorner and Mattson operated on 88 patients for cysts in a total of 723,797 admissions to the Mayo Clinic, with an incidence of 0.012 per cent. For

diseases of the pancreas the incidence is estimated as 1 to 2 per cent.

#### CLASSIFICATION OF PANCREATIC CALCULI

Stones are organic (12.7 per cent lime salts) and inorganic (93.14 per cent calcium carbonate). They are classified as true when present in a duct or ductules and the result of retention and stasis of pancreatic juice. Single stones are the exception rather than the rule. False stones consist of calcium deposition primarily in the parenchyma, usually preceded by a pathological disturbance such as acute or chronic pancreatitis. According to Beling, this distribution of calcium, frequently referred to as pancreatitis petrificans, has a definite clinical picture characterized by a history of frequent excessive indulgence in alcohol followed by repeated attacks of acute gastritis, the intervals between which are symptom free. Diabetes mellitus is absent and the pancreas shows diffuse parenchymal calcification.

#### INCIDENCE OF LITHIASIS

The average incidence of lithiasis from a tabulation of necropsy figures is shown in Table II. In 6,000 roentgen examinations, Morrison and Bogan found an incidence of 0.07 per cent. Snell and Comfort have called attention to the increasing number of reports in the literature during recent years. Lüdin, after a preliminary roentgenogram of the postmortem pancreas, dissected all glands showing heavy shadows; he found stones in 28 out of 542 organs for an unusual incidence of 0.51 per cent. Beling, Baker and Marquis found 1 case in 754 consecutive gastrointestinal examinations, an incidence of 0.13 per cent. This case report represents the sixteenth instance in the literature of disseminated calcification; Beling, Baker and Marquis, and King and Waghelstein have collected a total of fifteen.

#### RELATION OF CYST AND LITHIASIS

A rather general clinical impression, derived chiefly at operation or autopsy, exists

that cysts are not infrequent sequelae of duct obstruction due to stones. This belief has not been substantiated by experimental or statistical evidence. While the literature is replete with experimental observations

TABLE II

INCIDENCE OF LITHIASIS FROM NECROPSY STUDIES

Author	Necropsies	Calculi
Mayo-Robson	6,708	3
Möckel	23,314	6
Simmonds	36,000	15
Barron	3,437	3
Zeckwer	10,300	5
Mayo	10,000	9
Rockwern and Snively	7,402	3
Guy's Hospital (Snell and Comfort)	11,000	3
Archibald and Kaufman	6,070	1
Dillon	2,800	2
Total	117,031	52
	Per cent 0.044	

on the effects of obstructing the pancreatic ducts, the interest has been concentrated mainly on the external secretions. The pathological changes in the pancreas consist of atrophy of the acini and fibrosis of the parenchyma with, except in long-standing partial obstructions, preservation of the islands of Langerhans. Dilatation of ducts, ductules and acini has been described (Rich and Duff, and others), but evidence of the occurrence of cysts has been conspicuous by its absence. Archibald and Kaufman quote Lazarus as having produced a small retention cyst after simultaneously ligating the main duct and injecting tincture of iodine in the substance of the gland. This work, as far as can be determined, has not been confirmed.

Clinical observations suggesting the possibility of calculi as the cause of cysts are too numerous to enumerate. However, the presence of a stone in a duct does not necessarily implicate it as the etiological factor; intracystic calculi have also been described. Again, many cysts have been found for

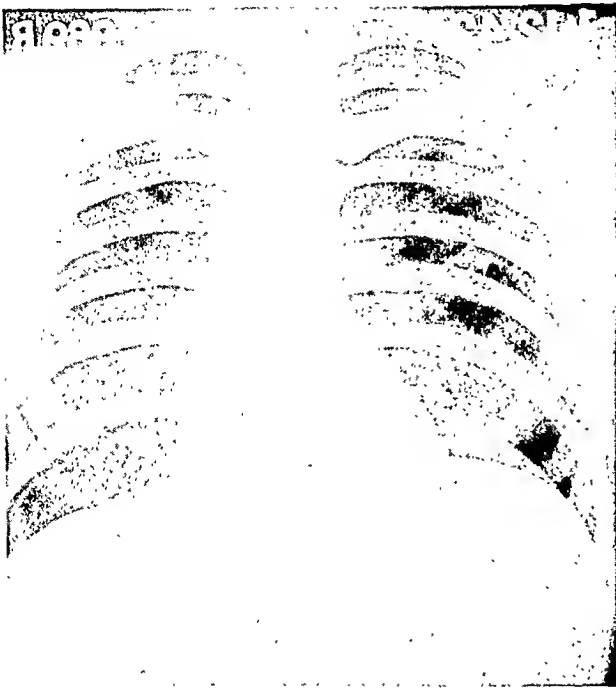


FIG. 1. The diaphragm on the left is elevated.

which no etiological explanation is available. There are other and more plausible theories of cyst formation. Better understood are the obstructions due to strictures, cancer, biliary stone at the ampulla of Vater, pressure of a duodenal diverticulum, congenital atresia and metaplasia of the duct epithelium.

The evidence seems to indicate that some initial pathologic disturbance of the pancreas is a common precursor of both cysts and calculi; the high incidence of associated biliary tract disease and atrophy and fibrosis of the gland in both conditions suggest this conclusion. In addition, the facility with which calcium is deposited in diseased tissue is well recognized; an obstructed duct with retention and stasis of the secretion, is a fertile area for precipitation of calcium salts. Acute pancreatitis may give rise to cysts or calculi. Rich and Duff have clearly demonstrated that acute hemorrhagic pancreatitis results from necrosis of vessel walls, due to trypsin liberated when the pressure in the ducts is raised as a direct consequence of obstruction. Similarly, it is not difficult to conceive of pancreatic ferments causing cystic degeneration. De Takáts and Mackenzie list cysts as a

sequela of acute pancreatitis. Should areas of necrosis undergo calcification, the typical picture of disseminated pancreatic lithiasis would result. Warren has shown an incidence of 1 per cent of stones in the pancreas of patients with diabetes; this is 23 times the average incidence. Andersen studied the main duct in 12 of 45 patients with cystic fibrosis of the pancreas; in 4, dissection was impossible, in 1 case definite atresia and in 2 stenosis was present. In some of these cases she found concretions in the dilated acini. Another case in point is that described by McWhorter. His patient had a hepaticoduodenostomy for congenital dilatation of the cystic duct fourteen years before her death. Diabetes developed and she died of hypertension and nephrosclerosis. At necropsy, the pancreas was almost completely replaced by fat and fibrous tissue. The major and minor ducts showed stenosis and saccular dilatations. Multiple



FIG. 2. A flat film of the abdomen shows calcific shadows in the left upper quadrant on a level with the second lumbar vertebra.

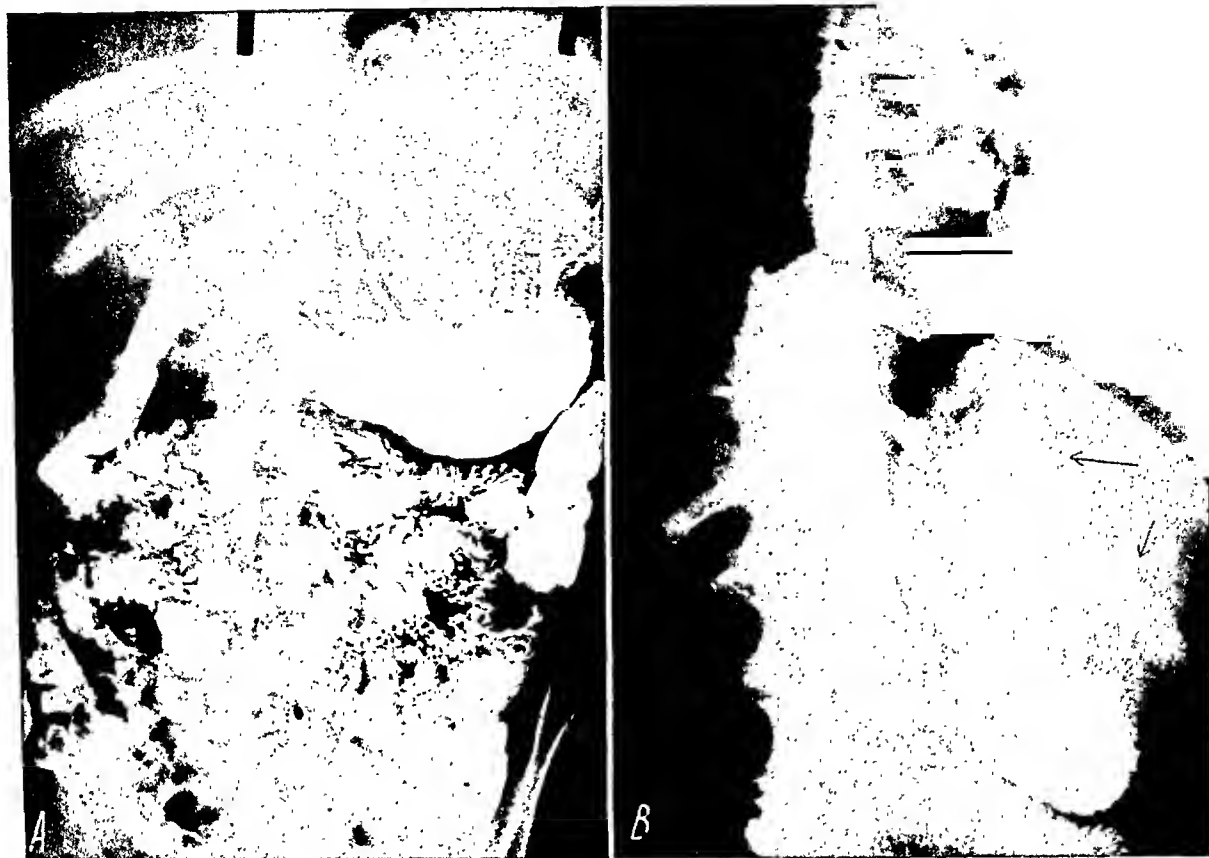


FIG. 3. *A*, posteroanterior roentgenogram showing evidence of extrinsic pressure by an oval mass. The rugae are flattened and concentrically displaced. *B*, oblique roentgenogram. Note thinning of folds of stomach and infiltration of wall of the fundus and body on the side of the greater curvature.

calculi but no cysts occurred in the dilated saccular branches of the minor duct, while retention cysts but no calculi occurred along the major duct. One retention cyst measured 3 cm. in diameter and 9 cm. in length.

#### CASE REPORT

H. T., male, aged twenty-eight, Army officer, was transferred from a station hospital to an Army general hospital on January 9, 1942, with a diagnosis of duodenal ulcer with severe hemorrhage. The present illness dated back two years and consisted of episodes of gastric difficulty characterized by severe pain in the abdomen and left back, nausea and vomiting, requiring opiates for relief. These episodes recurred every three to five months, lasted one to three days and were usually precipitated by indiscretions in diet or drink. The abdominal pain of the attack on December 16, 1941, radiated to the left back and base of the neck and was so excruciating that the patient slashed his wrists. The duo-

denal hemorrhage necessitated several blood transfusions at the station hospital.

The past history revealed the patient to be a more than moderate drinker, with occasional bouts of rather excessive alcoholic intake. In 1934 a horse rolled over the patient, injuring his left side. On another occasion he was struck in this same area by a polo mallet. In 1936 while tussling, he was rendered unconscious by a kick in the left renal area.

On physical examination, the patient was of slender physique; he appeared chronically ill with evidence of recent weight loss. There was impairment of mobility of the left diaphragm, distention of the abdomen, a palpable liver and tenderness of the lower ribs, posteriorly, on the left. The examination of the blood showed a hemoglobin of 87 per cent; red blood cells, 4,920,000; white blood cells, 10,550; polymorphonuclears, 74 per cent; lymphocytes, 25 per cent; monocytes, 1 per cent. The Kahn test and urinalysis were negative. The stool showed no occult blood or ova. The blood sugar was



FIG. 4. Combined gastrointestinal series and barium enema, again showing evidence of pressure and destruction of the wall of the stomach; the transverse colon is displaced slightly downward by the barium-filled pyloric portion. Note the normal bulb.

87.5 mg. per 100 cc. The total and free hydrochloric acid, non-protein nitrogen and phenol-sulfonphthalein determinations were normal. Subsequent urinalysis showed an occasional trace of sugar; the blood sugar 140 mg. per 100 cc. The glucose tolerance curve was diabetic type. The stool was negative for fat, but positive for undigested starch.

Roentgenographic studies showed an elevated left diaphragm (Fig. 1), calcification in the pancreatic area (Fig. 2) and downward displacement of the left kidney. The proximal two-thirds of the stomach was markedly compressed by an extrinsic oval mass, such that the rugae were thinned out and concentrically displaced. While the folds were intact, the gastric wall along the greater curvature of the fundus and body was infiltrated (Fig. 3). A combined gastrointestinal series and barium enema (Fig. 4) showed a slight downward displacement of the transverse colon by the distal third of the stom-

ach. With the patient in the Trendelenburg position, a "shelf-like" defect was noted on the posterolateral aspect of the body (Fig. 5).

On gastroscopy a large crevice with approximated edges was seen on the anterior wall just distal to the cardia; this was interpreted as a benign ulcer.

During his stay in the hospital, the patient gained weight and strength but the pain in his abdomen and back persisted, especially after meals. On March 16, 1942, the patient was operated upon. The omentum showed evidence of an inflammatory reaction. Firm adhesions were present about the inferior surface of the liver and anterior surface of the stomach. A large tumor mass about 3 inches in diameter could be felt which seemed to be in or behind the stomach at the cardiac end. The pancreas was normal in size, but hard and nodular throughout its entire length; its tail continued into the above described mass. Many adhesions were seen between the pancreas and the posterior wall of the stomach. The mass was firmly

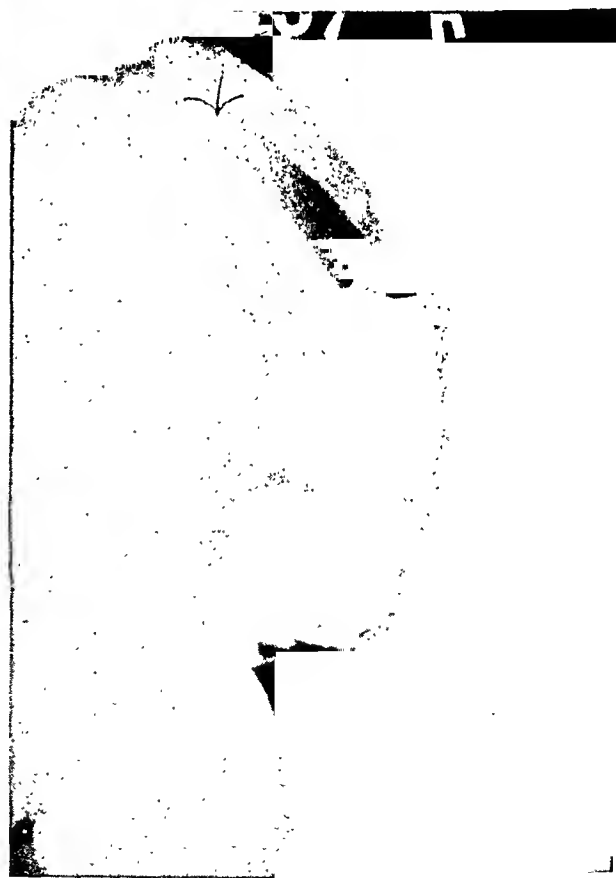


FIG. 5. Oblique roentgenogram with patient in Trendelenburg position, showing obtuse angle formed by mass and wall of stomach.

attached to the posterior surface of the stomach; its wall was fairly thick and tense, but compressible. A needle was introduced and 200 cc. of clear straw-colored fluid was aspirated. No attempt was made to remove the cyst; a catheter for drainage was securely fixed to the interior of the cyst.

The section of the cyst wall removed was found to be composed entirely of dense, partly hyalinized fibrous connective tissue containing a moderate number of scattered polymorphonuclear cells. No cyst lining was seen. The cyst fluid had a high amylase activity; 0.003 cc. digested 0.02 gram of starch.

After a stormy postoperative course for three days the patient improved rapidly. The drainage tube was removed three weeks postoperatively. Urine, blood sugar and glucose tolerance tests were normal. Follow-up roentgenograms at seven weeks (Fig. 6) showed relief of the external pressure on the stomach. At fifteen weeks the stomach appeared almost normal; peristaltic



FIG. 6. Oblique projection showing result of alleviation of extrinsic pressure seven weeks after operation. Note infiltration of wall of lesser curvature.

waves were frequent, deep and regular. Some evidence of infiltration of the lesser and greater curvatures remained, however (Fig. 7).

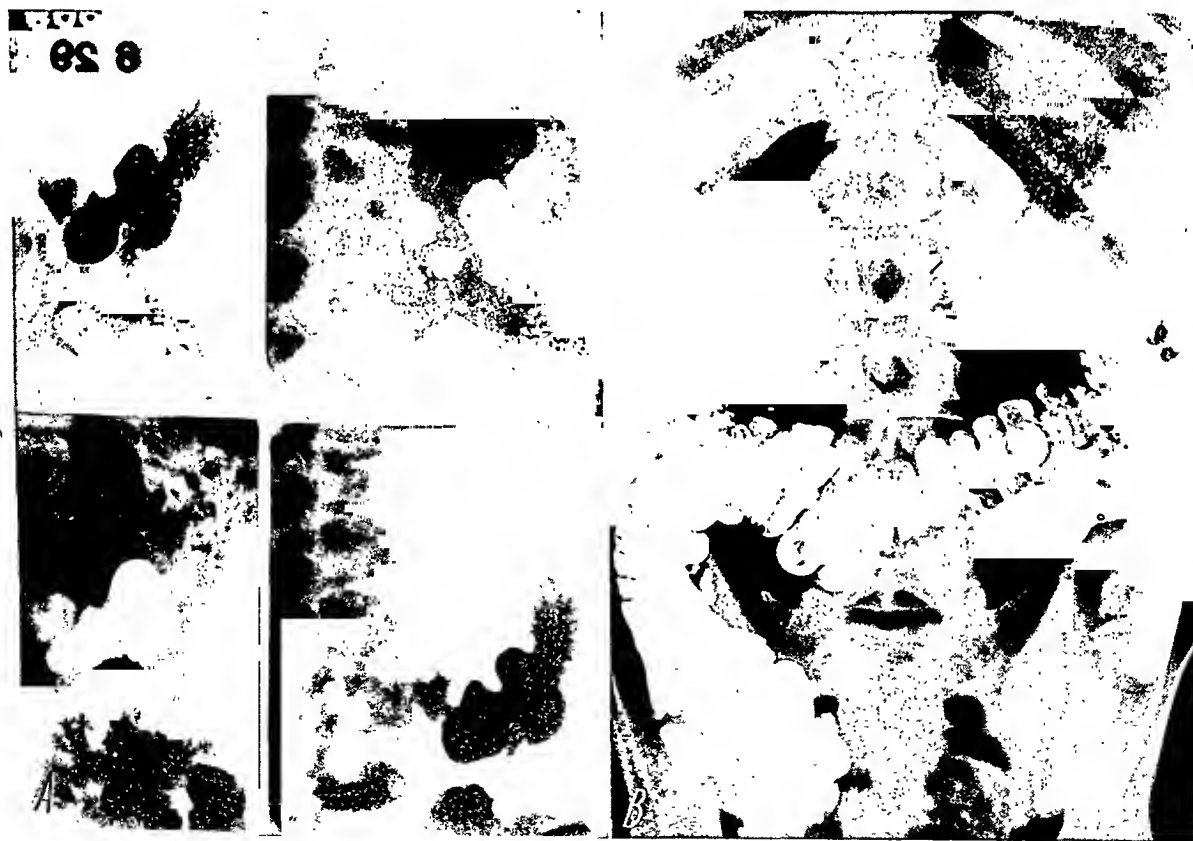


FIG. 7. *A*, serial roentgenograms showing stomach almost normal. Peristalsis is regular, the rugae are fairly normal in appearance. The lesser and greater curvatures in the region of the body and fundus, however, still show presence of a pathologic condition. *B*, six hour roentgenogram; the stomach is empty. There is better visualization of the pancreatic calcification.



## COMMENT

The association of stones and cyst in this case must be considered as coincidental. There is ample evidence for the traumatic basis of the cyst; Case states that 20 per cent of cysts are due to trauma. There are sufficient findings to make a diagnosis of pancreatitis to which the lithiasis can be attributed; it is somewhat unusual in that the stones are present in the parenchyma and ducts involving the body and tail.

Rupture of a pseudocyst may be spontaneous or result from trauma. The most frequent site of perforation is in the free peritoneal cavity; it may occur in the small bowel, colon and less often the stomach. Frequently the symptoms simulate a perforated peptic ulcer and, as pointed out by Koucky, Beck and Todd, there is considerable difficulty in making a preoperative diagnosis. The seriousness of the symptoms does not permit time-consuming tests for pancreatic disease, so that the nature of the pain is significant. Pain situated to the left of the midline, or pain radiating to the left or back should raise the question of a pancreatic lesion.

The differentiation of cyst of other origin is usually not difficult. The problem arises with cancer of the stomach or pancreas. Malignant lesions generally destroy the mucosal folds. When a cyst is present, the rugae are thinned out and displaced; in this case, concentrically. The pressure defect of cancer is not smooth and clear-cut as in cyst, nor is it possible to erase it with a return to some degree of normality of the stomach.

## SUMMARY

1. Pancreatic cysts and stones are classified. The classification for cysts is not new; to it cystic fibrosis has been added. Disseminated parenchymal calcification is emphasized as a definite disease entity.

2. The incidence of cyst from necropsy material is 0.061 per cent; of stone, 0.044 per cent. The latter figure is misleading since recent reports indicate a higher incidence. Because of the awareness of pan-

creatic disease and improved biochemical and roentgen techniques, the diagnosis of lithiasis is made more frequently than heretofore.

3. Contrary to general opinion, cysts are not sequelae of lithiasis. It is the exception rather than the rule. Evidence indicates that the same initial pathological condition, except trauma, is probably the precursor of both cyst and stone.

4. The case of pseudocyst reported presents the following interesting features:

a. Traumatic origin with spontaneous rupture into the stomach simulating bleeding peptic ulcer.

b. Association with disseminated parenchymal calcification, which of itself is extremely rare, only 16 cases, including this report, having been published in the literature to date.

c. Marked pressure on stomach with flattening, thinning out and concentric displacement of rugae.

d. Infiltration of wall of stomach in the absence of destruction of mucosal folds.

e. Return of the stomach to approximately normal appearance following operation.

5. It is emphasized that the possibility of pancreatic disease should not be overlooked when the pain is typical in location and radiation. The roentgen appearance of a smooth, well defined pressure defect of the stomach with concentric displacement of the folds strongly suggests a cyst. Associated evidence of infiltration of soft tissue is not always indicative of a malignant lesion.

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# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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*Forty-fifth Annual Meeting:* Joint Meeting of the American Roentgen Ray Society and the Radiologi-

cal Society of North America, Palmer House, Chicago, Ill., Sept. 24-29, 1944.

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*Twenty-eighth Annual Meeting:* 1944, to be announced.

## OBSERVATIONS BY A CLINICIAN ON SOME ADMINISTRATIVE PRACTICES IN HOSPITALS

RECENTLY it was my privilege to read a number of articles dealing with the many and varied phases of hospital administration. In perusing these publications, I was forcefully reminded of some thoughts that have arisen in my mind during a twenty-seven year period of close association with institutions for the care of the sick. One is that the business part of the organization is usually conducted with the greatest efficiency. With the well recognized tendency of the professional staff of most hospitals to be lacking in a real concern for the financial condition of such institutions, it is fortunate that men of the caliber with whom I have been associated are so often at the helm of this side of the hospitals' activities. Otherwise, it is undoubtedly true that bankruptcy would be facing many of them a greater proportion of the time.

Speaking from the standpoint of the clinician, however, there are at least two vital phases concerning the conduct of the hospital which are often grievously neglected. One is the regrettable lack of a genuine effort on the part of the present day hospital administrator to develop in the non-medical personnel an ever present kindly sympathetic attitude in all of their dealings with every patient, regardless of who they are and what their illness may be. The other criticism is the almost universal failure of the hospital administrative staff to understand the importance of medical research. To me, the hospitals have now developed to the point where they are efficient business organizations and for this we have the medical administrative officers to thank. Now is the time, in my opinion,

when they should make a determined effort to overcome their two most obvious and remediable defects, as outlined above. In the articles which I read, an astonishingly small amount of space is devoted to these two gross deficiencies despite the fact that they were supposed to represent the best thought concerning *all that is of value for the betterment of the hospital from the administrative standpoint.*

The training of the non-medical personnel to manage patients in a satisfactory manner is a golden opportunity sadly neglected in most institutions. It has always seemed to me that several easily recognized mistakes contribute to this difficulty. One is that inefficient and poorly trained employes with relatively small salaries are placed in administrative positions which have the most important contacts with the public. Second, as these individuals are often of mediocre ability, the responsibility of altering hospital rules, under the proper circumstances, cannot be delegated to them. Consequently certain injustices are done to our patients. Third, the persons assigned to dealing with the public are not only rude in occasional instances, but more often they display an obvious urgency to hurry with their duties, which has the same unpleasant effect. To deal with either a normal or sick person hastily indicates to him or her that their problem is secondary in importance to something else. Goldwater in an article "On Humanizing the Hospital" states a real truth when he says, "a natural incongruity between personal service and a large scale organization is at the bottom of such trouble . . . . The ambition of youthful superintendents, eager to demon-

strate their executive ability, tend easily in the direction of drafting of rules; but humane administration calls for the breaking as well as the making of rules."

The necessity of certain hospital regulations is appreciated and many of the most irksome of those imposed by the administration have bothered me less when I have taken the trouble to inquire into their rationale. Nevertheless, I implore the modern hospital administrator to believe me when I reiterate to him that the success of his organization is not measured entirely in terms of dollars and cents. The public is inclined to forgive him for almost anything except an attitude of the staff which suggests a callous disregard for the sensitive emotions of a sick person and their friends and relatives. This apparent indifference of the administrative personnel seems so paradoxical because many hospital superintendents whom I have met are humane, public spirited, kindly, personable individuals, who seem to have even a special penchant for warm friendships. In other words, often their personalities are not in accord with the conduct of their institutions, in respect to the management of the public.

The other point which has not been fully appreciated by hospital executives is the

important place of research in the modern institution for the care of the sick. In the past this function of the hospital has been considered as unworthy of support, or even scornfully regarded as a needless expense by some. It has been too obvious in the past, when it has been supported by the hospital, that it is the first to be lopped off the budget when funds are low. If these two statements alone are accepted, it is an indication that most superintendents consider it purely an unimportant ancillary function of the institution. Yet all concerned with the future of hospitals are reminded that the ultimate aim of such institutions, which is service to society, is likely to fall below the mark unless the medical staff is engaged in some type of medical investigative work. It need be only a simple, practical problem, but one which is calculated to improve medical practice. To fail to investigate is to fail to think in medicine. The support of research by hospital funds is almost non-existent at present, yet it is a most important aspect of practice in any institution devoted to the care of the sick. It goes further than any other single factor in guaranteeing a high grade of medical attention to the patients, which is the ultimate goal of any medical organization.

CYRUS C. STURGIS



*Bachrach*

## KARL KORNBLUM, M.D.

1893—1944

DR. KARL KORNBLUM was born in Evansville, Indiana, on March 19, 1893, and died at the University Hospital in Philadelphia on May 16, 1944, at the age of fifty-one, after an illness of only a few hours. The immediate causes of death were a cerebral thrombosis and a coronary thrombosis. Prior to this Dr. Kornblum,

like his former chief Dr. Pancoast, had been ailing for several years from hypertension.

Dr. Kornblum came from the Middle West, and he inherited the characteristics of his forbears which provided him with a level head and common sense, which in him were augmented by a kindliness of nature that endeared him to his friends.

After graduating from the University of Indiana in 1916, Karl Kornblum obtained his degree in Medicine from the University of Pennsylvania in 1919. After two years of internship and one year of residency in obstetrics at the Hospital of the University of Pennsylvania, he turned his talents toward surgery, and rose to be chief of the Outpatient Department of the University Hospital during 1923 and 1924. He then went into private practice, but soon gave that up to return to the University Hospital where he became associated with Dr. Pancoast, and with whom he remained until 1933, when he became the Director of the Department of Radiology at the Graduate Hospital. In 1938 Dr. Kornblum resigned from the Graduate Hospital to accept the chair of Radiology at Jefferson Medical College, vacated by the death of Willis F. Manges. He held this chair from 1938 to 1942. He returned to the University of Pennsylvania in January, 1943, as Clinical Professor of Radiology and Associate in the Department of Radiology of the Hospital of the University of Pennsylvania, where he remained until his death.

Dr. Kornblum was one of those rare individuals who had a gift for teaching, and although he had done a considerable amount of clinical investigation and published many articles, he will be remembered long for his teaching ability. He had the rare gift of keeping the attention of his students. Because of this ability he was called upon to give a great many lectures at home and abroad, and he was constantly preparing for these lectures, the preparation of which was not a chore but a source of relaxation.

In reviewing the contributions of Karl Kornblum one finds it difficult to evaluate which will live longest, but it is universally agreed that his contributions to the study of the urinary tract during the early investigations of uroselectan and other media, and his contributions to the study of the respiratory tract will continue to be informative to those going into the specialty of radiology.

In 1925 Dr. Kornblum married Miss

Mabelle Edwards, who has always been a most sympathetic and devoted wife. They have two daughters, Joan who is sixteen and Ann who is fourteen. It is my impression that their home life has been most unusual and extremely happy. Karl had no particularly hobby except that he enjoyed his family, his work, and his friends. Consequently he spent a great deal of time with his family at home and in travel, and they, like those of us who worked with him, will miss him keenly.

Karl Kornblum held the following appointments in the University of Pennsylvania prior to the time he became a Professor at Jefferson Medical College:

Instructor of Surgery, School of Medicine, 1922-1929.

Assistant Research Medicine, School of Medicine, 1923-1924.

Instructor of Radiology, Graduate School of Medicine, 1927-1934.

Instructor of Roentgenology, School of Medicine, 1929-1930.

Instructor of Radiology, School of Medicine, 1931-1933.

Assistant Professor of Radiology, Graduate School of Medicine, 1934-1938.

Director, Department of Radiology, Graduate Hospital, 1934-1938.

He was President of the Philadelphia Roentgen Ray Society 1933-1934, and was a member of many scientific societies. In all of these societies he participated in their scientific deliberations.

As a physician and a man Karl Kornblum was unusually gifted. Even though he must have had knowledge of his impending catastrophe, none of us who worked with him knew anything about it. He was a man in every sense of the word, and has fully justified the confidence which his teachers, colleagues and friends entrusted to him. As time passes, many will arise to attempt to fill his place, but it can be said without qualification that any man who can combine those rare attainments possessed by Karl Kornblum of being a brilliant teacher, an excellent clinical investigator, and a man of unquestionable integrity, should be most happy.

EUGENE P. PENDERGRASS

# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer.*

## MEETINGS OF ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary*, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Joint Meeting of American Roentgen Ray Society and Radiological Society of North America, Palmer House, Chicago, Ill., Sept. 24-29, 1944.

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary*, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary*, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio.

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary*, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Joint Meeting of American Roentgen Ray Society and Radiological Society of North America, Palmer House, Chicago, Ill., Sept. 24-29, 1944.

#### RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

*Secretary*, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

#### SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

*Secretary*, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.

#### RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

*Secretary*, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

#### SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

*Secretary*, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

#### RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION

*Secretary*, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

#### RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

*Secretary*, Dr. Roy G. Giles, Temple, Texas.

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary*, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

#### CHICAGO ROENTGEN SOCIETY

*Secretary*, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary*, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary*, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.

#### DENVER RADIOLOGICAL CLUB

*Secretary*, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary*, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

#### FLORIDA RADIOLOGICAL SOCIETY

*Acting Secretary*, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary*, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

#### INDIANA ROENTGEN SOCIETY

*Secretary*, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meeting held the second Sunday in May annually.

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary*, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary*, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

#### NEBRASKA RADIOLOGICAL SOCIETY

*Secretary*, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

#### NEW ENGLAND ROENTGEN RAY SOCIETY

*Secretary*, Dr. Hugh F. Hare, Lahey Clinic, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

#### RADIOLOGICAL SOCIETY OF NEW JERSEY

*Secretary*, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

#### NEW YORK ROENTGEN SOCIETY

*Secretary*, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

#### NORTH CAROLINA ROENTGEN RAY SOCIETY

*Secretary*, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

\* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.



## NORTH DAKOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

## CENTRAL NEW YORK ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

## OHIO RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. E. McCarthy, 707 Race St., Cincinnati. Meets at time and place of annual meeting of Ohio State Medical Association.

## PACIFIC ROENTGEN SOCIETY

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

## PENNSYLVANIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. L. E. Wurster, 416 Pine St., Williamsport.

## PHILADELPHIA ROENTGEN RAY SOCIETY

*Secretary*, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

## PITTSBURGH ROENTGEN SOCIETY

*Secretary*, Dr. R. G. Alley, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

## ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

## ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

*Secretary*, Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

## ST. LOUIS SOCIETY OF RADIOLOGISTS

*Secretary*, Dr. E. W. Spinzig, 2646 Potomac, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

## SAN DIEGO ROENTGEN SOCIETY

*Secretary*, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

## SAN FRANCISCO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Martha Mottram, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Toland Hall, University of California Hospital, second six months at Lane Hall, Stanford University Hospital.

## SHREVEPORT RADIOLOGICAL CLUB

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

## SOUTH CAROLINA X-RAY SOCIETY

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

## TENNESSEE RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

## TEXAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Herman Klapproth, Sherman, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGEN-  
OLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

## UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

## VIRGINIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

## WASHINGTON STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

## X-RAY STUDY CLUB OF SAN FRANCISCO

*Secretary*, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

## CUBA

## SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

## BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH  
THE RÖNTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE  
(CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

## FACULTY OF RADIOLOGISTS

*Secretary*, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

## SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE  
BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

## CANADIAN ASSOCIATION OF RADIOLOGISTS

*Secretary*, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton, Alberta.

## SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL  
ASSOCIATION

*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

## SOUTH AMERICA

## SOCIEDAD ARGENTINA DE RADIOLOGIA

*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

## CONTINENTAL EUROPE

## SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNT-  
GEN-GESELLSCHAFT)

*Secretary* for French language, Dr. A. Grosjean La Chaux de Fonds.

*Secretary* for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

## SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

*Secretary*, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD:  
USSR in the State Institute of Roentgenology and  
Radiology, 6 Roentgen St.

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

## LENINGRAD ROENTGEN RAY SOCIETY

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

## MOSCOW ROENTGEN RAY SOCIETY

*Secretaries*, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

## SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

## FRANKLIN MEDAL AWARDED TO DR. COOLIDGE

On April 19, 1944, Dr. William D. Coolidge, vice-president in charge of research for the General Electric Company, was awarded the Franklin Medal by the Franklin Institute. The award was given Dr. Coolidge "in recognition of his scientific discoveries, which have profoundly affected the welfare of humanity, especially in the field of the manufacture of ductile tungsten and in the field of improved apparatus for the production and control of x-rays."

*Science* (May 5, 1944, 99, 367) states: "Since the founding of the Franklin Gold Medal in 1914, the face of which carries a medallion of Benjamin Franklin done from the Thomas Sully portrait of Franklin owned by The Franklin Institute, it has been awarded by the institute to such figures as Thomas A. Edison, Guglielmo Marconi, Charles Fabry, Pieter Zeeman, James H. Jeans, Orville Wright, Albert Einstein and Charles F. Kettering.

"Dr. Coolidge has won many scientific awards, among them the Howard N. Potts and the Louis Edward Levy Medals of The Franklin Institute, and an honorary M.D. degree from the University of Zurich. . . .

In his acceptance of the Franklin Medal, Dr. Coolidge revealed a new development—that white-hot steel, moving at a speed of twenty miles an hour as it emerges from a rolling mill, can have its thickness accu-

rately measured by x-rays. His work in the development of the present vacuum tube and the tube making use of the cascade principle is well known to all radiologists. The modern incandescent lamp was made possible because of Coolidge's development of the drawn tungsten filament and Langmuir's contribution of filling the lamp with gas. Tungsten, always a brittle metal because of its crystalline structure, became both ductile and fibrous as a result of Coolidge's researches and tireless effort.

## DR. McNAMEE HONORED

Dr. Edgar P. McNamee of Cleveland, Ohio, a well known radiologist and a member of the American Roentgen Ray Society, was made President Elect of the Ohio State Medical Association at its Ninety-eighth Annual Meeting held in Columbus, May 2-4, 1944.

## NEW YORK ROENTGEN SOCIETY

At the meeting of the New York Roentgen Society held on May 15, 1944, the following officers were elected for the ensuing year: *President*, Dr. Maurice M. Pomeranz; *Vice President*, Dr. William H. Boone; *Secretary*, Dr. Ramsay Spillman; *Treasurer*, Dr. Arthur J. Bendick; *Member of Executive Committee*, Dr. Ross Golden. Meetings are held on the third Monday of each month from November through May, at 8:30 P.M., at the Academy of Medicine.



## REFRESHER COURSES

JOINT MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY AND THE  
RADIOLOGICAL SOCIETY OF NORTH AMERICA*Abstracts of Courses Offered*

PALMER HOUSE, CHICAGO, ILLINOIS

*September 24-29, 1944*

A series of Refresher Courses will be presented at the time of the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, at the Palmer House, Chicago, Illinois, September 24-29, 1944.

These courses of post-graduate instruction will be given from 2 to 5 P.M. and 7 to 9 P.M., Sunday, September 24, and from 8:30 to 10 A.M. daily thereafter during the meeting. Nothing else will be scheduled during these hours, and courses have been so arranged that those interested in a particular subject may enroll in a related series.

The courses will be held on the Fourth and Club Floors of the Palmer House. Admission will be by ticket only. Reservations for enrollment will be made in the order in which they are received. Those who are not members of either of the two participating societies will be charged a fee of two dollars (\$2.00) for a single course or a maximum of five dollars (\$5.00) for the series. Members of the Armed Forces, Residents and Fellows in Radiology will be exempt from these charges.

Read the description of the courses, noting particularly the days upon which they are offered: study the Plan of Presentation and select carefully your choice for each day (and also indicate a second and third choice) as the number attending each course will be limited. If the directions listed in the Plan of Presentation are carefully followed, errors in enrollment will be avoided.

If the Refresher Courses are not filled by the time of the meeting, tickets will be available at the registration desk, Sunday, September 24, and thereafter.

It may be necessary to alter or revise some of the courses and to change some of the instructors; we will, however, adhere as closely as possible to your choice for the Refresher Courses.

**Course No. 1: Sunday, 2-5 P.M.****Diseases of the Esophagus, Stomach and Duodenum: Panel Discussion****FAY H. SQUIRE, M.D.**

Chicago, Illinois

Presiding

**JAMES B. EYERLY, M.D.****JOHN M. DORSEY, M.D.****GEORGE J. RUKSTINAT, M.D.****DANELY P. SLAUGHTER, M.D.**Staff of Presbyterian Hospital, University  
of Illinois(Rush) College of Medicine, Chicago, Illinois  
(by invitation)**JAMES B. EYERLY, M.D.**

1. Medical aspects of diseases of the esophagus, stomach and duodenum.
  - a. Physiology. b. Types of diseases. c. Treatment.

**FAY H. SQUIRE, M.D.**

2. Radiologic examination of stomach and duodenum demonstrating pathologic changes.

**GEORGE J. RUKSTINAT, M.D.**

3. Pathologic anatomy of esophagus, stomach and duodenum.

**JOHN M. DORSEY, M.D.**

4. Surgery of the esophagus.
  - a. Anatomy. b. Surgical diseases.
    - (1) Congenital abnormalities. (2) Infections. (3) Tumors.

**DANELY P. SLAUGHTER, M.D.**

5. Surgery of stomach and duodenum.
  - a. Anatomy of stomach and duodenum. b. Surgery of gastric and duodenal ulcer and carcinoma. c. Congenital obstruction of duodenum. d. Chronic duodenal ileus.

**Course No. 2: Sunday, 2-5 P.M.****Roentgenologic Diagnosis of Neurological Lesions: Panel Discussion**

Staff of the University of Illinois,  
College of Medicine

Arranged by the late

**ADOLPH HARTUNG, M.D.**

Professor of Radiology

**T. J. WACHOWSKI, M.D.**

Assistant Professor of Radiology

Presiding

**ERIC OLDBERG, M.D.**, Professor of Neurology  
and Neurological Surgery (by invitation)

**PERCIVAL BAILEY, M.D.**, Professor of Neurology  
and Neurological Surgery (by invitation)

**PAUL C. BUCY, M.D.**, Professor of Neurology  
and Neurological Surgery (by invitation)

**A. S. J. PETERSEN, M.D.**, Associate in  
Radiology

Brief historical review of the roentgenologic methods used in neurological diagnosis. Technical procedures with and without contrast media. Interpretation of negatives with correlation of clinical and pathological findings. Specific information in response to requests from the audience.

**Course No. 3: Sunday, 2-5 P.M.****2-3 P.M. Nuclear Physics.**

**K. W. STENSTROM, Ph.D.**, Minneapolis, Minn.

Discussion will include a simple description of the newer nuclear physics, including sub-nuclear particles such as protons, neutrons, positrons, mesotrons, etc., and the apparatus for producing them such as the cyclotron, the electrostatic generator and the betatron.

**3-5 P.M. Information Please**

**U. V. PORTMANN, M.D.**, Cleveland, Ohio,  
Moderator

**EDITH H. QUIMBY, Sc.D.**, New York, N. Y.

**OTTO GLASSER, Ph.D.**, Cleveland, Ohio

**JAMES L. WEATHERWAX, M.S.**,  
Philadelphia, Pa.

**ROBERT S. LANDAUER, Ph.D.**,  
Highland Park, Ill.

Don't only try to "stump the experts" but send in questions on the Physics of Radiology which have been bothering you these many years. Send questions to Dr. U. V. Portmann, Cleveland Clinic, Euclid Ave. at 93rd St., Cleveland 6, Ohio.

**Course 4: Sunday, 7-9 P.M.****Carcinoma of the Breast: Panel Discussion**

**T. LEUCUTIA, M.D.**,

Harper Hospital, Detroit, Mich.

Presiding

**J. J. MOORE, M.D.**, Pathologist, Chicago, Ill.  
(by invitation)

**HARRY A. OBERHELMAN, M.D.**, Professor of  
Surgery, Loyola University School of Medicine,  
Chicago, Ill. (by invitation)

**B. H. ORNDOFF, M.D.**, Professor of Radiology,  
Loyola University School of Medicine,  
Chicago, Ill.

**JANET TOWNE, M.D.**, Loyola University School  
of Medicine (by invitation)

**MAJOR JAMES C. COOK, M.C.**,  
Detroit, Mich. (by invitation)

**E. WALTER HALL, M.D.**, Detroit, Mich.

Dr. Leucutia will briefly introduce the newer aspects on therapy, and especially the estrogenic theory, of mammary carcinoma. Dr. Moore will discuss the various pathologic aspects. Dr. Oberhelman will present the surgery of carcinoma of the breast. Dr. Towne will discuss the question of bilateral oophorectomy as a routine procedure, especially in the young, in all operable cases of mammary carcinoma and take up the problem of roentgen castration as compared to surgical castration. Major Cook will present the aspect of colloidal lead therapy in conjunction with roentgen therapy. Dr. Orndoff will discuss the radiation procedures as practiced in the various stages of mammary carcinoma. Dr. Hall will discuss the late sequelae incident to over-irradiation, the pleuro-pulmonary changes as well as the osseous changes.

**Course No. 5: Sunday, 7-9 P.M.****Film Reading Session**

**MERRILL C. SOSMAN, M.D.**, Boston, Mass.  
Presiding

**ROSS GOLDEN, M.D.**, New York, N. Y.

**EUGENE P. PENDERGRASS, M.D.**,  
Philadelphia, Pa.

Those attending the course are invited and requested to bring reports and roentgenograms of interesting or difficult cases for presentation and informal discussion. Only cases in which the diagnosis has been proved or in which the evidence is conclusive should be submitted. Those conducting the session will depend upon voluntary submission of material by members of the audience.

**Course No. 6: Monday, 8:30-10 A.M.****B. R. KIRKLIN, M.D., Rochester, Minn.****Gallbladder and Pancreas**

1. Cholecystography by the oral method will be described and discussed. Emphasis will be laid on the necessity of employing meticulous care in administering the dye, in executing the roentgenographic technique, and in interpreting cholecystographic response. Criteria of distinction between normal and abnormal response will be presented, and illustrative cholecystograms will be shown.

2. (a) Disclosure of tumors of the pancreas with the aid of opaque ingesta.
- (b) Roentgenographic demonstrations of pancreatic calculi.

**Course No. 7: Monday, 8:30-10 A.M.****L. R. SANTE, M.D., St. Louis, Mo.****Roentgenological and Pathological Study of the Pneumonias**

In recent years many causes have been found for pneumonia other than the pneumococcus. Many of these pneumonias have been described as atypical pneumonia of unknown etiology. The etiological agents for these unusual forms are so multiple and varied that they are apt to cause confusion to the roentgenologist in his understanding of the subject. To clarify the situation, a comparative study of the roentgen manifestations of the various types of pneumonia with the pathological pictures which they produce has been undertaken.

**Course No. 8: Monday, 8:30-10 A.M.****EDITH H. QUIMBY, Sc.D., New York, N. Y.****Practical Problems in Dosage Measurement**

This discussion will include the measurement of the quantity of x-rays in roentgens; the quality in half-value layer; the significance of air vs. backscatter measurements; percentage depth dose; exit dose; depth dose charts; isodose charts and dosage records.

**Course No. 9: Monday, 8:30-10 A.M.****FRED O. COE, M.D., Washington, D. C.****Pelvimetry by Modification of Various Methods**

A survey roentgenogram of the abdomen is first taken. This is followed by the conventional antero-posterior view as described by Thoms; a lateral view with the patient standing, using the dots for measurements; and a posteroanterior view of the outlet following the method of Chassard and Lapine—a total of four films. The report is a modification of that used by Snow. All methods have been modified from the original description.

**Course No. 10: Monday, 8:30-10 A.M.****MAX RITVO, M.D., Boston, Mass.****Diaphragmatic Hiatus Hernia: Hernia of the Stomach through the Esophageal Hiatus of the Diaphragm**

Diaphragmatic hernia of the hiatus type is a relatively common condition and must always be included among the causes of upper abdominal and chest complaints. This condition has not received from many clinicians and roentgenologists the full attention it merits. The symptomatology is indefinite and variable; hence, clinical diagnosis is usually impossible and the patient is thought to have gallbladder disease, peptic ulcer, angina, etc. Many patients with hiatus hernia have been operated upon because of these incorrect diagnoses. The roentgen ray offers an accurate and dependable method of establishing the diagnosis; it demonstrates the size of the hernia and its relationship to adjacent structures. In addition, it is important in determining the question of operability.

In this presentation, the roentgen methods of demonstrating diaphragmatic (hiatus) hernia will be described in detail. The differential diagnosis will be discussed. The signs and symptoms will be outlined and an attempt made to establish a clinical syndrome which may make a clinical diagnosis possible in many instances. The treatment of hiatus hernia will be outlined.

Lantern slide demonstration will include hiatus hernia, other types of diaphragmatic hernia, and various lesions in this region which may cause confusion in diagnosis.

**Course No. 11: Tuesday, 8:30-10 A.M.****F. E. TEMPLETON, M.D., Cleveland, Ohio****Technique of Diagnosis of Duodenal Lesions by the Mucosal Relief Method**

The conditions influencing the demonstration of a mucosal surface, the equipment and the technique used in examining the stomach and duodenum are discussed. The factors influencing the demonstration of mucosal surfaces are outlined as follows:

- A. Physical Factors
  1. The state of the medium
  2. The condition of the mucosa
  3. The contents of the lumen
  4. The build of the patient
- B. Anatomical Factors
  1. Demonstration of single surfaces
  2. Demonstration of superimposed surfaces
  3. Clinical applications
    - a. Under normal conditions
    - b. Under pathological conditions
- C. Physiological Factors
  1. Passive factors
    - a. Respiration

- b. Position of the patient
- c. Transmitted pulsation
- d. Pressure
  - (1) Extrinsic
  - (2) Intrinsic
- e. Muscular
  - (1) Tonus
  - (2) Peristalsis

2. Active factors

- a. Autonomic theory of Forssell.

After briefly discussing the filming fluoroscope or "spot" machine, the technique of examination will be discussed in detail as follows:

- A. Preparation of the patient
- B. The media
- C. Planning the examination
- D. Actual roentgenologic examination
  - 1. A routine method
    - a. Fluoroscopy
  - 2. Procedures for special situations
    - a. Diaphragmatic hernia with a brief discussion of the phrenic ampulla
    - b. Cascade stomach
    - c. Pyloric obstruction
    - d. High posterior bulb, and antrum
    - e. Air in the duodenal bulb
    - f. Patients too ill to stand
    - g. Infants
  - 3. Indications for exposing of the film
    - a. The "spot" film
    - b. The "survey" film
  - 4. Application of pressure

**Course No. 12: Tuesday, 8:30-10 A.M.**

**W. WALTER WASSON, M.D., Denver, Colo.**

**Diseases of the Lesser Circulation**

This course will be an attempt to discuss the dynamics of the lesser circulation with a detailed presentation of the anatomy and the physiology. Every day the roentgenologist is endeavoring to evaluate in terms of pathology the air content of the lungs and the dynamics of the chest as a whole, and particularly of the lesser circulation. It is hoped that a few additional factors may be added to the present knowledge in regard to the lesser circulation. There will be a brief presentation of the clinical diseases of the lesser circulation.

**Course No. 13: Tuesday, 8:30-10 A.M.**

**K. E. CORRIGAN, Ph.D., Detroit, Mich.**

**Radium Physics**

This will include natural radioactive disintegration, the particles emitted by radioactive materials, half life, average life, units and the uranium disintegration series.

**Course No. 14: Tuesday, 8:30-10 A.M.**

**WALTER C. POPP, M.D., Rochester, Minn.**

**Roentgen Therapy for Infectious Processes**

A short introduction will be given covering the theories as well as the experimental work done by various workers, and the action of roentgen rays on infectious processes will be explained. Emphasis will be placed on the selection of technique for both acute and chronic processes. The handling of acute infections with small dosages will be considered in some detail. Statistics will be shown indicating the experience in the treatment of acute sinusitis at the Mayo Clinic. Methods of treatment of a variety of common infections will be presented as individual entities.

**Courses No. 15 and 20: Tuesday and**

**Wednesday, 8:30-10 A.M.**

**MERRILL C. SOSMAN, M.D.**

**HOWARD ARMSTRONG, M.D. (by invitation)**  
**ORVILLE BAILEY, M.D. (by invitation)**

**Boston, Massachusetts**

**Peter Bent Brigham Hospital and the  
Harvard Medical School**

**Four Rare Diseases—Clinical, Pathological and  
Roentgenological Aspects: (1) Acute Disseminated  
Lupus; (2) Periarteritis Nodosa;  
(3) Erythema Nodosum;  
(4) Sarcoidosis**

(Courses require two days for completion.  
Not a repeater)

These four diseases appear frequently enough in the roentgenologist's practice to warrant detailed descriptions of their clinical course, laboratory diagnosis, pathological findings and, above all, the roentgenographic aspects. One of them (acute disseminated lupus) has responded well to roentgen therapy. Complete summaries of each disease from the above mentioned aspects will be presented along with illustrative cases and methods of treatments.

**Course No. 16: Wednesday 8:30-10 A.M.**

**ROSS GOLDEN, M.D., New York, N. Y.**

**Certain Aspects of Motility Disturbances in  
the Small Intestine**

This course will include a discussion of the normal anatomy and the basic physiology involved in the three groups of intestinal movements. After dealing briefly with the normal, the disturbed motor function associated with nutritional disorders, liver disease, hypoproteinemia, ileus, and allergy will be discussed. An attempt to explain these disturbed motor phenomena in terms of basic physiology will be made.

**Course No. 17: Wednesday, 8:30-10 A.M.****LESTER W. PAUL, M.D., Madison, Wis.****Diseases of the Mediastinum and Associated Conditions**

In this discussion will be included those lesions which produce mass shadows of abnormal character within and adjacent to the mediastinum. The anatomy of the mediastinum and of the tracheobronchial lymph nodes will be reviewed, followed by a discussion of the roentgen anatomy of these parts. The roentgen aspects of the diseases affecting the mediastinal and tracheobronchial lymph nodes will be presented in some detail, including acute and chronic nonspecific infections, fungous infections, tuberculous adenitis in adults and primary tuberculosis. In this latter connection the lymph node changes seen in erythema nodosum will be discussed. Also reference will be made to sarcoid disease and an attempt will be made to correlate these conditions as far as present knowledge permits. The various primary and secondary tumors involving the lymph nodes will be covered, particularly Hodgkin's disease, lymphosarcoma, and metastases from primary tumors elsewhere.

Illustrative cases will be used in which serial roentgenograms show the appearance of the chest before the development of the disease, its course, and in some instances a return to normal. Emphasis will be placed on the recognition of early changes as shown by serial roentgenograms. Other diseases which may produce abnormal shadows in the mediastinum will be discussed, including lesions of the spine, pulmonary artery, aorta, esophagus, acute and chronic mediastinitis, intrathoracic thyroid, enlargement of the thymus, and certain forms of cancer of the bronchial tree. Cardiac lesions will not be included except as they must be differentiated from extracardiac abnormalities.

**Course No. 18: Wednesday, 8:30-10 A.M.****OTTO GLASSER, Ph.D., Cleveland, Ohio****Electronics in Radiology**

This new course, being given for the first time, will correct the impression, being foisted on the American public, about "newness" of electronics which actually is about fifty years old.

**Course No. 19: Wednesday, 8:30-10 A.M.****MAJOR MILTON FRIEDMAN, M.C., A.U.S.****Biologic Reactions of Tissue to Radiation**

The development of radiation therapy techniques has been predominantly based on the disappearance of the tumor and the cure rate. These indices are too remote from the immediate event to permit observations and evaluations of a specific technique. Hence the great number of "schools" of treatment.

The application of certain clinical and experimental observations of the immediate response of the tumor are helpful in reducing empiricism in radiation therapy. The mechanisms of the histological effect of radiation on tumors, the recovery processes, and the lethal tumor dose are three features discussed and correlated.

Histologic examination of biopsy specimens of a tumor under irradiation yields information of fundamental importance concerning the efficiency of treatment technique for a particular case. Radiation destroys tumor cells in several ways. Radiosensitive tumors are affected differently from radioresistant tumors. Observation of the rate and method of recession of different tumors suggests specific rates of application of radiation for each type of tumor.

Consideration of the recovery process becomes progressively more important with increased understanding of its behavior.

It is necessary to construct the plan of treatment on the basis of the daily and total tumor dose in order to intelligently apply the above principles. This procedure permits intelligent handling of a lesion, reveals the inefficiency of many commonly employed irradiation techniques, and places the treatment on a substantial basis.

**Course No. 20: Wednesday, 8:30-10 A.M.**

Continuation of Course No. 15.

**Course No. 21: Thursday, 8:30-10 A.M.****HARRY M. WEBER, M.D., Rochester, Minn.****Lesions of the Colon Frequently and Easily Overlooked**

Advanced pathologic processes occurring in the large intestine usually produce relatively marked morphologic changes in the part of the intestine affected, and so are discovered without great difficulty at roentgenologic examination. Certain clinically important lesions, however, never become large, or produce alarming symptoms even when small, or are encountered so early in their development that very obvious morphologic changes have not as yet taken place, and thus are easily overlooked at roentgenologic examination. This discussion will be limited to the roentgenologic diagnosis of small neoplastic lesions of the large intestine, and to those roentgenologically recognizable changes which signify the earliest manifestations of certain important non-neoplastic lesions of this division of the alimentary tract. The conduct of the roentgenologic examination of the large intestine will be reviewed briefly, and advantages and limitations of the various diagnostic procedures currently used in this field will be discussed in considerable detail.



Course No. 22: Thursday, 8:30-10 A.M.

C. C. BIRKELO, M.D., Detroit, Mich.

### Pulmonary Tuberculosis

This presentation will consist of a lantern slide demonstration of both the common and unusual forms of pulmonary tuberculosis. The primary tuberculous infection, as it occurs in the child and young adult, will be demonstrated. Reinfection tuberculosis of both the productive and exudative types will be shown and the commonly accepted methods of treatment will be briefly discussed.

Differential diagnosis will include roentgen-ray demonstration of cases which resemble tuberculosis but have been found to be bronchopneumonia, primary and metastatic tumors of the lungs, bronchiectasis and cystic disease, lung abscess, mitral heart disease, and silicosis. All material presented will consist of proved cases.

Course No. 23: Thursday, 8:30-10 A.M.

SAMUEL BROWN, M.D., Cincinnati, Ohio

### Roentgen Differentiation of Abdominal Tumors

This course will cover the roentgen diagnosis of extra-gastrointestinal tumors by an indirect method of approach which consists in the study of the stomach and intestines in their relation to the neighboring organs. It has been found that, in the presence of a tumor arising from any of the adjacent organs, characteristic changes take place in the relation, position, and contour of the hollow viscera according to the position of the body as a whole. With these facts at our disposal, it has been possible to diagnose the presence of, location, and origin of many a tumor in the abdomen.

Course No. 24: Thursday, 8:30-10 A.M.

MAURICE LENZ, M.D., New York, N.Y.

### Roentgen Therapy of Hodgkin's Disease and Lymphosarcoma

Though primary regression of most clinically appreciable masses of Hodgkin's disease and lymphosarcoma is usually obtained by roentgen therapy, survival beyond three years is observed in only a small proportion of cases. In an effort to analyze the causes of these poor results, the relationship between the clinical characteristics and the technique of roentgen therapy was studied in all patients with Hodgkin's disease and lymphosarcoma treated by roentgen irradiation at the Presbyterian Hospital, New York, between 1915 and 1941. The result of this investigation will be discussed informally.

Courses No. 25 and 30: Thursday and

Friday, 8:30-10 A.M.

EUGENE P. PENDERGRASS, M.D.

GEORGE W. CHAMBERLIN, M.D.

P. BOLAND HUGHES, M.D. (by invitation)

Philadelphia, Pennsylvania

### Roentgenology of the Urinary Tract

(Course requires two days; the first three items will be considered on the first day and the second three on the second day)

1. Roentgen methods and materials
  - a. Evaluation of types of examination
  - b. Use and limitation of roentgen procedures
  - c. Dangers of urography
2. The normal urinary tract
  - a. Physiology
  - b. Anatomy
  - c. Roentgen interpretation
3. Anomalies and variants
  - a. Embryology of some of the common anomalies
  - b. Role of the anomalies in the development of disease
  - c. Late results of anomalies
4. Roentgen interpretation of genitourinary tract disease
  - a. Stones
  - b. Infections
  - c. Tumors
  - d. Cysts
  - e. Miscellaneous
5. Value of urography in disease primary outside of the urinary tract
  - a. Aneurysms
  - b. Retroperitoneal tumors and infections
6. Cystoscopy and urethrography

Course No. 26: Friday, 8:30-10 A.M.

LEO G. RIGLER, M.D., Minneapolis, Minn.

### Roentgen Manifestations of Acute Abdominal Disorders

1. Roentgen technique in acute abdominal disorders.  
Special technical procedures are necessary in the examination of patients. Variations from the usual technique in the examination of the abdomen, the difficulties, and special procedures necessary will be detailed.
2. Indications for roentgen examination in acute abdominal disorders.  
The various acute processes in the abdomen in which roentgen examination is of great assistance in establishing either the diagnosis or aiding in determining the extent and nature of the process will be presented.



## 3. Analysis of the scout film of the abdomen.

- a. The normal appearance of the roentgenogram of the abdomen without contrast medium.

The soft tissue shadows, the appearance of the gastrointestinal tract with and without preparation and under varying conditions will be demonstrated.

- b. The abnormal roentgenogram without contrast medium.

A discussion of the physiologic and pathologic factors in the production of changes in the abdomen will be undertaken.

An analysis of the various findings which can be obtained with different types of acute abdominal disorders and their differential diagnosis will be presented.

Demonstrations will be given of the roentgen findings in : (1) peritonitis; (2) intra-abdominal abscess; (3) small intestinal obstruction; (4) large intestinal obstruction.

## 4. Value of roentgen examination in the acute abdominal disorders.

An estimation of the reliability of the various roentgenologic signs and their contribution toward the practical handling of the patient will be presented.

**Course No. 27: Friday, 8:30-10 A.M.****HOLLIS E. POTTER, M.D., Chicago, Ill.****Roentgen Findings in Low Back Pain**

A review of both the more common and the rarer roentgen findings in low back pain which must be considered in the clinical diagnosis, the prognosis, and the treatment. Differentiation between vertebral injury and vertebral disease, congenital and acquired.

**Course No. 28: Friday, 8:30-10 A.M.****ROBERT A. ARENS, M.D.****IRVING F. STEIN, M.D. (by invitation)****Michael Reese Hospital, Chicago, Ill.****Gynecography: Pneumoperitoneum and Hysterosalpingography**

The presentation will consist of a round table discussion including the history, armamentarium required, and technique for complete gynecography, including transuterine and transabdominal methods, pneumoperitoneum and hysterosalpingography alone and combined. The roentgenological procedure including the exposure, distance, posture, etc., will also be shown. Consideration will also be given to the diagnostic value of the method, its therapeutic application in tuberculous peritonitis and salpingitis and also the value of the transuterine insufflation in sterility. The teaching value of the method to students will be stressed. Lantern demonstration.

**Course No. 29: Friday, 8:30-10 A.M.****HERBERT E. SCHMITZ, M.D.****JOHN F. SHEEHAN, M.D. (by invitation)****Chicago, Ill.****Treatment of Carcinoma of the Uterus**

This course will consider early diagnosis, planning of treatment, dosage, and the more common complications of carcinoma of the uterus and of the uterine cervix. Pathologic changes induced by irradiation in carcinoma of the uterus and of the uterus itself will be presented.

**Course No. 30: Friday, 8:30-10 A.M.**

Continuation of Course No. 25.

## PLAN OF PRESENTATION

Sunday 2-5 P.M.	Monday 8:30-10 A.M.	Tuesday 8:30-10 A.M.
1. Diseases of the Esophagus, Stomach and Duodenum F. H. Squire, M.D. J. B. Eyerly, M.D. G. J. Rukstinat, M.D. J. M. Dorsey, M.D. D. P. Slaughter, M.D.	6. Gallbladder and Pancreas  B. R. Kirklin, M.D.	11. Technique of Diagnosis of Duodenal Lesions by Mucosal Relief Method.  F. E. Templeton, M.D.
2. Roentgenologic Diagnosis of Neurological Lesions T. J. Wachowski, M.D. Eric Oldberg, M.D. Percival Bailey, M.D. P. C. Bucy, M.D. A. S. J. Petersen, M.D.	7. Roentgenological and Pathological Study of Pneumonias  L. R. Sante, M.D.	12. Diseases of the Lesser Circulation  W. W. Wasson, M.D.
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18. Electronics in Radiology  Otto Glasser, Ph.D.	23. Roentgen Differentiation of Abdominal Tumors  Samuel Brown, M.D.	28. Gynecography: Pneumoperitoneum and Hysterosalpingography  R. A. Arens, M.D. I. F. Stein, M.D.
19. Biologic Reactions of Tissue to Radiation  Maj. M. Friedman, M.C.	24. Roentgen Therapy of Hodgkin's Disease and Lymphosarcoma  Maurice Lenz, M.D.	29. Treatment of Carcinoma of the Uterus  H. E. Schmitz, M.D. J. F. Sheehan, M.D.
20. Continuation of 15. (1) Acute Disseminated Lupus; (2) Periarteritis Nodosa; (3) Erythema Nodosum; (4) Sarcoidosis	25—(continuous)  Roentgenology of the Urinary Tract E. P. Pendergrass, M.D. G. W. Chamberlin, M.D. P. Boland Hughes, M.D.	30—

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Monday 8:30-10 A.M.						
Tuesday 8:30-10 A.M.						
Wednesday 8:30-10 A.M.						
Thursday 8:30-10 A.M.						
Friday 8:30-10 A.M.						

## BOOK REVIEWS

*Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.*

**OUTLINE OF ROENTGEN DIAGNOSIS: AN ORIENTATION IN THE BASIC PRINCIPLES OF DIAGNOSIS BY THE ROENTGEN METHOD.** By Leo G. Rigler, B.S., M.B., M.D., Professor of Radiology, University of Minnesota, Minneapolis, Minnesota. Second edition. Fabricoid. Price, \$6.50. Pp. 196, with 254 illustrations. Philadelphia: J. B. Lippincott Company, 1943.

This book is exactly what the title indicates. It represents a comprehensive outline of roentgen diagnosis, and is an excellent book for the student in roentgenology, or for the general practitioner who wishes to learn briefly diagnostic criteria of various diseases.

This book includes eleven sections in which the following subjects are considered:

Section One. General Principles of Roentgen Diagnosis.

Section Two. Bones and Joints.

Section Three. Diseases of the Spine and Spinal Cord.

Section Four. The Skull and its Contents.

Section Five. The Thorax.

Section Six. The Digestive Tract.

Section Seven. The Biliary Tract.

Section Eight. The Abdomen, Miscellaneous.

Section Nine. The Urinary Tract.

Section Ten. The Female Generative Organs.

Section Eleven. Miscellaneous Topics.

In addition to the text the author has included 254 well chosen illustrations and diagrams.

The author is an experienced radiologist who has a large practice. He is entirely competent to judge the type of cases with which the average practitioner is confronted.

The publishers are to be congratulated on the type of print, which is readable and not tiring to the eyes, and the illustrations, which are excellent.

EUGENE P. PENDERGRASS

**THE 1943 YEAR BOOK OF RADIOLOGY.** *Diagnosis:* Edited by Charles A. Waters, M.D., Associate in Roentgenology, Johns Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital; Associate Edi-

tor, Whitmer B. Firor, M.D., Assistant in Roentgenology, Johns Hopkins University; Assistant in Roentgenology, Johns Hopkins Hospital; On leave with the Armed Forces. *Therapeutics:* Edited by Ira I. Kaplan, B.Sc., M.D., Director, Radiation Therapy Department, Bellevue Hospital, New York City; Associate Radiologist, Lenox Hill Hospital, New York City; Clinical Professor of Surgery, New York University Medical College. Cloth. Price, \$5.00. Pp. 456, with 378 illustrations. Chicago: Year Book Publishers, Inc., 1943.

Despite the problems and distractions of war, there seem to be enough advances in roentgen diagnosis, enough improvements in treatment, and enough new and interesting cases to warrant the publication of numerous scientific journals. So long as articles are worth publishing in journals, so long is there need for abstracting and collecting them in convenient form for the busy man. In fact, there is now greater need than ever to conserve the time and energy of war weary doctors.

This need is met by the latest Year Book of Radiology which contains abstracts, brief reviews and comments on the most important publications of 1942 and the early months of 1943. Following the old custom of the automobile manufacturers, the Year Book appears several months before the year is over, so the present volume has been in use for a long period and has already justified the advance notices of publishers and early reviewers.

The "radiologic practice quiz" of twenty questions appearing on the cover is very intriguing, and the number might well be expanded to one hundred or more. Many specialists would no doubt fail to answer correctly all of the twenty questions, and reading of the text is bound to bring up many bits of valuable information. That there are also points of controversy is borne out by frequently interspersed editorial comments, for Waters, Kaplan and Firor do not hesitate to criticize unfavorably as well as favorably, and there are, of course, many who would not agree with either the author or the comment.

Dr. Kaplan has reviewed the entire field of

radiation therapy in an introduction of twenty-eight pages. This is alone worth the reading but it stimulates one to search the abstracts and even the original articles for further information. Waters and Firor have followed the same excellent plan of previous years in classifying diagnostic articles by body systems and tissues. The selections are well chosen for reader interest and the illustrations are numerous and well reproduced.

Space to list the contents is lacking but the student is well rewarded for the time spent with the 1943 Year Book of Radiology. Those who have past volumes will make sure that their series is unbroken.

E. WALTER HALL

**FRACTURES AND DISLOCATIONS FOR PRACTITIONERS.** By Edwin O. Geckeler, M.D., Fellow of the American College of Surgeons; Fellow of the American Academy of Orthopaedic Surgeons; Diplomate of the American Board of Orthopaedic Surgery. Third edition. Cloth. Price, \$4.50. Pp. 361, with 320 illustrations. Baltimore, Maryland: Williams & Wilkins Co., 1943.

The author has achieved a condensed textbook on fractures and dislocations which well expresses the best conservative opinions of therapy today. This is a well balanced book, riding no hobbies of therapy, but stressing the fundamental principles of fracture therapy with emphasis on conservative methods of treatment.

By word and illustration, the essential details of treatment are presented with thorough simplicity. The author has properly emphasized the types of fractures which the practitioner would treat; the more complicated fractures and problems are recognized as properly referred to the more experienced bone surgeon.

An excellent bibliography is appended to each chapter for those who desire more information.

This book is an excellent text for students and an excellent review of the modern concept of treatment of fractures and dislocations for the practitioner. It is quite possible that this readable simple book will stimulate the reader to more extensive study of original articles and to texts of broader scope. Frequently, the large encyclopedic textbooks present such a colossal task to the busy practitioner that they remain

unread. This text is interestingly written, authentic and of distinct educational value.

CARL E. BADGLEY

**THE HOSPITAL IN MODERN SOCIETY.** Edited by Arthur C. Bachmeyer, M.D., Director, University of Chicago Clinics; Director, Hospital Administration Course, University of Chicago, and Gerhard Hartman, Ph.D., Director, Newton Hospital, Newton Lower Falls, Mass. Cloth. Price, \$5.00. Pp. 768. New York: The Commonwealth Fund, 1943.

This volume is an excellent compilation of carefully evaluated articles dealing with the many and varied phases of hospital administration. They have been collected for the use of the hospital director, his assistant, the department head, and board members or trustees who are desirous of a more thorough understanding of hospital procedure. The topics presented include almost every aspect of medical administration, ranging from the duties of the trustees and the financial control of an institution, to food service and housekeeping. Not the least important is a carefully selected and extensive bibliography which is appended to each section of the book. Certainly this publication should be a valuable and reliable source of information to those mentioned above, or to anyone who wishes to familiarize himself with any division of hospital administrative practice.

In reading the articles in this collection, one cannot help but be impressed with the debt which the public in general, and the clinicians in particular, owe to the hospital administrators for the modern and effective business methods which they have developed for the management of institutions for the care of the sick. With the inability of the average physician to manage his own business affairs efficiently, there might be the same application of slipshod ideas to hospital management if it were not for the now highly developed and efficient specialized principles of business management which have been developed by the hospital administrators of this country. This book is highly recommended to those who have an interest in this particular phase of hospital practice, for it can be read with profit by anyone who cares to familiarize himself with the business aspect of such organizations.

CYRUS C. STURGIS

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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN DIAGNOSIS

### SKELETAL SYSTEM

SEMMES, R. EUSTACE, and MURPHEY, FRANCIS.

Syndrome of unilateral rupture of sixth cervical intervertebral disk, with compression of seventh cervical nerve root. *J. Am. M. Ass.*, April 10, 1943, 121, 1209-1214.

From a review of the literature it would seem that most of the ruptured discs in the cervical spine produce either bilateral or unilateral cord pressure and that discs causing nerve root symptoms alone are very rare. Semmes and Murphey believe that exactly the reverse is true; that an undetermined number of patients with pain in the precordium, in the shoulder and in the arm, who heretofore were thought to have coronary thrombosis, angina pectoris, arthritis of the cervical spine, brachial plexus, neuritis and neuralgia, bursitis, scalenus anticus syndrome, cervical rib or discogenetic disease will be found to have a rupture of one of the lower cervical discs. Unilateral rupture of the sixth cervical disc with compression of the seventh cervical nerve root causes as definite a syndrome as similar lesions of the fourth and fifth lumbar discs. Four such cases are here reported, 3 of these already proved at operation.

Each patient gave a history of numerous cricks in the neck recurring intermittently for months or years preceding the attack of radiating pain. The pain radiated in each case to three general regions: (1) the precordium, (2) a point just medial to the upper angle of the scapula and (3) down the lateral and medial surfaces of the arm. In each instance there was considerable difficulty in breathing and a sense of impending death and in 1 case cyanosis. After a few days or weeks the precordial pain abated to some extent and that in the rhomboid region and arm became more pronounced. Three patients complained of definite numbness and weakness in the index finger and slight numbness in the middle finger. Roentgen examination of the cervical spine showed a straightening of the cervical curve in each instance. There was no evidence of hypertrophic arthritis in any of these cases at the beginning of symptoms. The diagnosis of this condition was made solely on

the basis of the history and physical findings. No contrast medium in the spinal canal was used.

The operative procedure was carried out under local anesthesia. Subtotal hemilaminectomy was performed and the loose fragments of fibrocartilage were removed, thus relieving the pressure on the nerve. Two of the 3 patients operated on now are relieved completely of all of their original pain; whereas the third, although relieved of the shoulder pain, still has some discomfort in the arm and occasional pain in the precordium.

Hypertrophic arthritis and/or narrowing of the intervertebral disc rarely causes nerve root pressure or pain. Rupture of any intervertebral disc may result in hypertrophic changes on the edges of the adjacent vertebrae.—S. G. Henderson.

DUNCAN, WILLIAM, and HOEN, THOMAS I. A new approach to the diagnosis of herniation of the intervertebral disc. *Surg., Gynec. & Obst.*, Aug., 1942, 75, 257-267.

The authors, working at the Hospital for Special Surgery maintained by the New York Society for the Relief of the Ruptured and Crippled, found that the accepted neurologic and myelographic criteria for diagnosis of the herniated disc often led to error. Therefore, they employed a new diagnostic approach which is proving satisfactory.

Three types of herniation were noted: (1) a simple herniating mass of fragmented cartilage and degenerative nuclear material distending the intact posterior capsule; (2) in the second type, the joint capsule has been ruptured and the cartilaginous sequestra have migrated into the extradural space; (3) there is fibrous fixation of the protrusion and involved nerve elements and frequently bony proliferation within the joint capsule.

*Diagnosis.* Special bending roentgenograms are taken in lateral flexion to both sides and in forward flexion and extension. In the majority of the authors' cases, these roentgenograms have demonstrated a lack of spinal mobility localized to the involved joint. On the involved side, the joint may fail to narrow as much as the

joints above and below or may even remain wedged open. Bending to the painful side usually demonstrates little, if any, resiliency within the affected joint. Lateral views of the spine with the patient in extreme flexion and extension may also demonstrate a mechanical obstruction in the posterior aspect of the joint which will be apparent in the view in extension. The involved disc will fail to allow extension as do the joints above and below. It is emphasized that these "bending films" serve primarily to establish the level rather than the presence of a disc protrusion.

A patient with a disc protrusion faces the problem of transmitting the body weight along the spinal column without compressing the diseased area of the disc, thus avoiding further extrusion of the cartilaginous debris along the course of the herniation. To do this, one must tilt the spine away from the involved area of the disc. This posture entails a list of the spine away from the side of the lesion, and, since the mass is extruding posteriorly, an attitude of forward flexion is assumed.—*Mary Frances Vastine.*

SMITH, ALAN DEFOREST, and MILLER, LAWSON E., JR. The laminagraph as an aid in the treatment of chronic osteomyelitis. *Surg., Gynec. & Obst.*, Oct., 1942, 75, 507-509.

One of the difficulties often encountered in the treatment of chronic osteomyelitis is the accurate localization of abscesses which give rise to recurrent attacks of pain, swelling, and fever. When a laminagraph was acquired by the New York Orthopaedic Hospital it was used in these cases. The authors conclude: (1) an increase of bone detail is available by the use of the laminagraph; (2) the laminagraph affords better localization of a bone abscess with regard to both site and level; (3) the laminagraph may help in the prevention of operation for just one abscess when more may be present; (4) the use of lipiodol in draining sinuses is suggested when roentgenographic examinations are made.—*Mary Frances Vastine.*

BLAISDELL, JACK, and HARMON, PAUL H. Suppurative joint disease and its relation to pyogenic osteomyelitis; a review of end-results of 67 involved joints in 57 patients; modern chemotherapeutics. *Surg., Gynec. & Obst.*, April, 1942, 74, 796-808.

The authors found 57 patients with suppurative

joints in the records of the Guthrie Clinic and these cases represent the basis for this comprehensive study of suppurative joint disease. The considerations in the article which are of roentgenological interest include:

1. The chief conditions to be considered in differential diagnosis are (a) acute rheumatic fever; (b) sympathetic sterile joint effusion produced by trauma or neighboring infection; (c) intermittent hydro-arthritis; (d) joint tuberculosis; (e) hemophilia; (f) traumatic hemarthrosis, which may accompany marginal fractures and "sprains"; (g) acute rheumatoid arthritis in children, Still's disease; (h) acute bursitis; (i) peri-articular cellulitis; (j) small fractures and sprains.

2. When the patient with suppurative joint disease is first examined no bone or joint abnormality will be seen on the roentgenogram unless the patient has had previous neighboring bone disease. (a) The earliest roentgen finding is narrowing of the joint space; (b) demineralization of the bones due to acute suppuration may not be visualized by roentgen examination until three to four weeks after onset. (It may be seen as early as seven days following the onset of the infection); (c) there is progressive demineralization of the bones as visualized by roentgenograms taken at weekly or fortnightly intervals; (d) if the pus is not removed, solution of the cartilage promptly occurs and the joint will show erosion of the bony articular cortex or sequestration of this structure with solution of the underlying cancellous bone.

3. A certain number of pyogenic joints are confused with tuberculous joint involvement as the roentgen appearance is likely not to be characteristic of either. Aspiration with or without joint irrigation is the only means of diagnosis.

4. Frequency of joint involvement by suppuration is in the following order: hip, knee, ankle, shoulder, elbow, and wrist.

5. The necessity of early diagnosis by joint aspiration and bacterial culture and smear is shown, since upon the results from bacterial culture and smear the proper chemotherapeutic agent is selected. When this information is lacking during the first few hours, the chemical agents that are active against the hemolytic *Staphylococcus aureus* are to be used presumptively and change, if any, made as the result of the bacteriological findings. In children who have acute joint complications following upper respiratory and middle ear infections, sulfanil-

amide is to be used presumptively.—*Mary Frances Vastine.*

BORAK, J. Relationship between the clinical and roentgenological findings in bone metastases. *Surg., Gynec. & Obst.*, Nov., 1942, 75, 599-604.

It has long been recognized that carcinomatous metastases may be present in bones without this invasion being visible roentgenologically. This is particularly true of the vertebral bodies. Tumor cells brought to the bone by the blood stream via the nutrient arteries, settle primarily in the wide spaces of the spongy portion. Thus, the compact portion of bone is affected primarily only in rare instances. The vertebrae are particularly rich in spongy bone so this is probably the reason why they are so often the site of predilection of metastases. Spongy bone forms a wide meshwork of very thin trabeculae while the compact bone forms a thick layer of dense bone tissue. Consequently, the spongy bone produces a shadow of much less density than the compact bone. It is, therefore, understandable that lesions in the vertebrae may go undetected since the latter consist exclusively of spongy bone.—*Mary Frances Vastine.*

THOMAS, ATHA. Vascular tumors of bone; a pathological and clinical study of twenty-seven cases. *Surg., Gynec. & Obst.*, April, 1942, 74, 777-795.

This paper is the result of a study of all the vascular tumors recorded with the Registry of Bone Sarcoma of the American College of Surgeons; it also includes 2 personal cases. An attempt is made to analyze and classify further all the vascular tumors of the Registry. An analysis of current opinions on the pathogenesis and classification of vascular tumors in general is presented in an attempt to clarify the confusion that exists concerning this controversial group of tumors.

#### *Benign Angioma.*

1. This is a highly differentiated structure composed of fully developed blood vessels, which grows slowly and with little evidence of cellular activity.

2. Probably the vertebrae are the most common site for these tumors. The flat bones of the skull, pelvis, and shoulder are involved frequently, the long bones of the extremities being next in frequency.

3. In the vertebrae the tumor often produces pressure on the cord with neurological signs of varying degree. Occasionally vertebral angioma associated with epidural angioma has been reported.

4. The roentgenographic appearance in the vertebrae is characteristic. There is an irregular absorption of bony trabeculae and a thickening of the remaining vertical trabeculae with resulting parallel vertical striations and loss of the normal homogeneous structure. Not uncommonly these trabeculations extend into the vertebral arches.

Involvement of the flat bones often presents a characteristic "sunburst" appearance. Bony trabeculations radiate from a common center.

The roentgenographic appearance of angioma of long bones has been described as the unique "soap bubble" effect. There are coarsely multiloculated areas of rarefaction which expand the shell of bone to paper-like thinness, giving a cystic appearance resembling giant cell tumor. In angioma, however, the loculations are somewhat smaller and within them there is a fine fibrillary framework. The cortex is usually not expanded as in giant cell tumor or bone cyst.

5. Treatment consists of irradiation or operation or both. The danger of severe hemorrhage from operation must be considered, especially in operations on the cranium and spine. Meyerding found angioma of bone to be somewhat radiosensitive, and under moderate dosage repeated at regular intervals for a number of months it gradually regresses until healed.

*Malignant Angioma.* Histologically, the malignant angiomas may be divided into two groups, the angio-endothelioma and the angiosarcoma.

1. *Angio-endothelioma.* A résumé of current opinion indicates that the question whether angio-endothelioma of bone exists as a pathological and clinical entity is still a controversial one although the evidence suggests that such a tumor of bone does occur. It is an angioblastic tumor but with an epithelium-like structure difficult to distinguish from metastatic carcinoma. Geschickter and Ewing state that angio-endotheliomas are usually found in the ends of long bones. The roentgenogram shows nothing which can be considered diagnostic. There is rarefaction and destruction, and rarely, bone production. Some reveal well defined septa.

2. *Angiosarcoma.* There seems to be almost as much confusion associated with the angio-

sarcoma group of vascular tumors as with angio-endothelioma. The author defines these tumors as those showing proliferating vascular endothelium with new blood vessel formation in which the vasoformative tendency is the predominant feature. The clinical and roentgenographic signs are in no way distinctive, being of little value in differentiating angiosarcoma from other malignant bone tumors.—*Mary Frances Vastine*.

ANDERSON, CARL E., and SAUNDERS, JOHN B. DE C. M. Primary adamantinoma of the ulna. *Surg., Gynec. & Obst.*, Sept., 1942, 75, 351-356.

The authors believe that the case reported is the first recording of this tumor in a long bone other than the tibia.

The adamantinoma is an infiltrating epithelial tumor, arising from basal cells. It grows in a stroma of fibrous tissue and reproduces, to a certain extent, the histological characteristics of the primitive tooth bud.

Pathologically, the tumor is a soft, spongy, gray, indistinctly lobulated, vascular growth which occupies the central portion of the shaft of the bone and expands it without breaking through the cortex.

Clinically, adamantinoma of the long bones exhibits the following characteristics: (1) it possesses a limited type of malignancy. It may erode the bone to a considerable extent but it will not invade adjacent tissues or metastasize; (2) either males or females may develop the tumor. The age incidence is from twenty-two to forty-six years; (3) the chronicity and slow growth of the tumor are noteworthy; the time elapsing between discovery of the tumor and surgical treatment in the reported cases has varied from ten months to sixteen years with the occurrence of only local extension; (4) all patients give a definite history of trauma; (5) aching pain is often noted but the usual presenting symptom is the presence of a tumor mass. Tenderness, increased local temperature, edema and fluctuation may be present in some instances; (6) the tumor has a very strong tendency to recur if not completely removed. (7) radiosensitivity of the tumor is low.

The treatment is complete surgical excision, resection, or amputation.

Roentgenologically, the tumor appears as a polycystic, expanding central tumor with sharp outlines and a fine trabecular pattern. No peri-

osteal reaction or new bone formation is seen. There are no worn or eroded margins. A fine honeycombed appearance is often seen which is not usually present in bone cysts or giant cell tumors.—*Mary Frances Vastine*.

VINKE, THEODORE H., and WHITE, EDGAR H. Congenital narrowing of the lumbosacral space. *Surg., Gynec. & Obst.*, May, 1943, 76, 551-555.

In roentgen interpretations of the painful low back, increasingly greater emphasis is being placed upon the finding of a narrowed lumbosacral intervertebral space. For the past several years, it has been stressed that such a narrowing usually resulted from a herniation of the nucleus pulposus. However, this is no longer felt to be true. A narrowing of the intervertebral space at the site of a ruptured disc probably occurs in only a small percentage of cases. In fact, it has been shown that narrowing often occurs at a different level than the site of extropulsion as found at operation.

Another explanation for the narrowing of the lumbosacral intervertebral space is the disintegration of the annulus fibrosus and nuclear material incidental to the wear and tear of life. The concept is particularly reasonable since such narrowing is seen in those backs which, through structural anomalies, are mechanically weaker than normal. Incomplete sacralization, asymmetrical facets, an acute lumbosacral angle, and defects in the posterior elements, all make a relatively vulnerable joint unstable.

The incidence of congenital narrowing of the intervertebral space occurs often enough to be of diagnostic significance. The authors reviewed the roentgenograms of the lumbosacral junction in 300 children and 3 such cases were found. It was believed that any narrowing occurring in this age group (five to fifteen years) not resulting from such obvious pathological processes as tuberculosis, sclerosis, osteochondritis, or osteomyelitis must be of congenital origin. Roentgenograms of these cases revealed associated anomalies, lumbarization or sacralization being present in all instances.

Six case reports are given in all of which there was narrowing of the lumbosacral intervertebral disc but in which the pain could be adequately explained on a basis other than that of a herniated disc. The absence of leg signs or reflex changes plus an excellent response to conservative management constituted the evidence

against a pathological process of the disc.—  
*Mary Frances Vastine.*

LEE, HAROLD G., and HORAN, THOMAS B. Internal fixation in injuries of the ankle. *Surg., Gynec. & Obst.*, May, 1943, 76, 593-599.

This paper classifies those injuries of the ankle that are operative. Operative reduction, when indicated, should be carried out as soon as possible, preferably within from twenty-four to forty-eight hours after the injury. The operative treatment which is required in each instance is outlined.

*Fracture of the Lower End of the Fibula.* The lower fibula may be fractured as the result of forcible external rotation of the foot or of turning the foot directly outward on the leg. The astragalus as it twists in the joint mortise and strikes against the edge of the external malleolus is the shearing force that causes the fracture. Such a fracture is the typical injury received in skiing when the point of the ski, turned outward, catches in the snow, and the skier pitches forward, twisting the ankle. The fracture line is usually oblique from side to side or extends as a long fracture line with its center at the joint surface. The exact circumstances under which operation is indicated in fractures of the lower end of the fibula are outlined.

*Trimalleolar Fractures.* The trimalleolar fracture, consisting of fractures of the posterior tibial surface and both malleoli, presents no problem when the triangular-shaped fragment of the tibia is small in size. However, when a large fragment is separated, it is difficult to reduce the fracture and to maintain the fragment in the corrected position. Disability is particularly marked in women, who are most likely to sustain this fracture, because of the fact that when high heels are worn the weight-bearing line falls through the posterior half of the tibial surface.

*Fracture of the Anterior Tibial Surface.* A fracture of the anterior weight-bearing surface of the tibia in which a wedge-shaped fragment is broken off and the foot displaced forward, requires operative reduction. This fracture is practically always of the comminuted type.

*Fracture of the Internal Malleolus.* Occasionally in an isolated fracture at the base of the internal malleolus, an obstacle to closed reduction is presented by a curtain of soft tissue that is interposed between the tibia and the fractured malleolar surface. If such a fracture is not ac-

curately reduced, a fibrous union takes place, causing the area to be tender and painful and the joint mortise to be unstable.

*Pott's Fracture.* Another obstacle to reduction (one obstacle was discussed in the preceding paragraph) in Pott's fracture is the dislocated posterior tibial tendon.

*Separation of the Tibia and Fibula.* A separation of the tibia and fibula as the result of the tearing of the tibiofibular ligament may occur in conjunction with a fracture in the region of the ankle or as a separate entity. If the condition is not recognized, disability may ensue from the disrupted relation between the astragalus and the tibia by the widening of the ankle mortise.

*Separation of the Lower Epiphysis of the Fibula.* In this epiphyseal injury, the fragment is rotated backward, with the tip of the fibula acting as a fulcrum, and it occasionally takes with it a jagged spicule of bone from the fibular shaft. Reduction by closed methods is prevented both by the fulcral end of fibula and spicule of bone.

*Recurrent Dislocation of the Peroneal Tendons.* Recurrent slipping of a peroneal tendon over the lower end of the fibula is accompanied by an uncomfortable jarring snap from which the patient seeks relief.—*Mary Frances Vastine.*

MILLER, DONALD S., and DE TAKATS, GEZA. Posttraumatic dystrophy of the extremities; Sudeck's strophy. *Surg., Gynec. & Obst.*, Nov., 1942, 75, 558-582.

Sudeck's atrophy was first described by Sudeck in 1900. Shuele found an incidence of post-traumatic dystrophy as high as 5 per cent among 500 cases of sprain. It is believed that if the diagnosis of this syndrome is made early enough a long standing disability may be avoided. There are certain criteria which make for correct diagnosis:

1. Persistent pain of a burning character with paroxysmal aggravations presented by a patient whose injury is properly immobilized, non-infected and seemingly on the way toward a normal course of repair, should make one suspicious of an early beginning reflex dystrophy.

2. The extremity is warm and there is edema of the subcutaneous tissues and joint capsule.

3. Osteoporosis does not occur until several weeks after the injury. There is spotty decalcification of the small bones of the hand or foot and in the metaphysis of long bones where vas-

cularity of the bone is the greatest. Later, the mottled, spotty bone atrophy becomes diffuse at which time it is indistinguishable from osteoporoses of other origin. It must be emphasized that the diagnosis should not be made on the basis of roentgenograms alone. The syndrome may be present without roentgen evidence or it may be subsiding when the bone changes are at their height. The greatest value of the roentgenograms lies in serial examinations.

### *Differential Diagnosis.*

1. Atrophy of disuse. This is painless and not associated with marked vasomotor phenomena. Bone atrophy is diffuse, comes on slowly and improves on resumption of activity of the part.

2. Bone atrophy due to inflammation of joints. There is usually actual destruction around the joint in these cases.

3. Aseptic necrosis of bone. A rarefaction of bone is seen in the aseptic necrosis following vascular occlusions.

### *Prevention.*

1. Careful attention to injuries affecting ligaments, tendons, and musculature as well as bone.

2. Early and adequate control of pain.

3. Alleviation of the patient's fear and anxiety.

The authors have done over 100 blood flow determinations on 12 patients. In posttraumatic dystrophy, an increased blood flow to the part has been demonstrated. A total of 33 patients suffering from early, intermediate, and late stages of the disease is reported.—*Mary Frances Vastine.*

BOTHE, FREDERICK A., SIMPSON, H. MURRAY, and ROWNTREE, LEONARD G. Traumatic and spontaneous fractures in exophthalmic goiter. *Surg., Gynec. & Obst.*, Sept., 1942, 75, 357-360.

To date, only 7 cases of spontaneous fracture in cases of exophthalmic goiter have been reported. In the majority of instances in which it has occurred, the hyperthyroidism has been marked, long continued, and accompanied by extreme demineralization and decalcification of the bony skeleton.

The case reported constitutes the only one in which both traumatic and spontaneous fractures have occurred following earlier partial removal of the thyroid gland.

Von Recklinghausen first described the demineralization of the skeleton in a case of hyperthyroidism in 1891. Aub *et al.* reported an increase in the excretion of calcium and phosphate in clinical hyperthyroidism. They found the average excretion in cases of thyrotoxicosis 231 times greater than that in a normal individual. The serum phosphatase has been found to be elevated in cases of hyperthyroidism. Pain is the outstanding symptom associated with the skeletal changes. The pain is relieved following thyroidectomy but the recalcification of the skeleton is a very slow process.—*Mary Frances Vastine.*

LEE, HAROLD G. Fractures of the humeral condyles in children. *Surg., Gynec. & Obst.*, July, 1942, 75, 97-102.

Thirty-two cases of fractures of the humeral condyles in which the end-results were studied are reviewed. In the series of 32 cases there are 13 fractures of the lateral condyle, 16 fractures of the medial epicondyle, 2 of the less common fractures of the internal condyle, and 1 of the rare fractures of the lateral epicondyle. Open intervention is the accepted method of treatment of these fractures. However, as is generally true when condylar fractures are treated conservatively, satisfactory functional results were obtained by closed methods in many of the cases in this series.

The roentgenographic study of the end-results were interesting:

(1) *Fractures of the External Condyle.* In the fractures that had been treated operatively, a well developed condyle in good position was seen. The fractures that had been handled conservatively showed an enlarged condyle with non-union or malunion.

(2) *Fractures of the Medial Epicondyle.* Roentgen studies of the end-results in these fractures usually showed an enlarged fragment that had pulled away from its bed. These changes were observed in cases that had been treated either operatively or conservatively. It is difficult to explain such findings in cases that have been reduced accurately. Proliferative islands of bone showed around the outer margins of the joint in most of the fractures involving the medial epicondyle. Then, too, failure of union between the medial epicondyle and the humeral shaft, which normally takes place about the eighteenth year of life, was noted in most instances. Of particular interest in the



roentgenograms of 2 cases of operative excision of the medial epicondyle were islands of bone that suggested regeneration.—*Mary Frances Vastine*.

SACHS, MAURICE D., and HILL, HAROLD A. Complications of infero-anterior (axillary) dislocation of the shoulder joint as demonstrated by roentgenograms. *Surg., Gynec. & Obst.*, Nov. 1942, 75, 639-646.

The authors believe that the mechanism of the infero-anterior dislocation is as follows: The arm is abducted and internally rotated. Trauma is transmitted along its longitudinal axis, forcing the head inferiorly under the inferior lip of the glenoid (subglenoid dislocation). The lateroposterior portion of the humeral head impinges on the glenoid lip as it is forced anteriorly through the capsule into the axilla.

Complications of the inferoanterior dislocation include: (1) The so-called compression defect in the lateroposterior head of the humerus. This is best seen when the roentgenogram is taken with the arm in internal rotation. A sharp vertical line of condensation extending downward from the top of the head of the humerus, parallel and slightly lateral to the shaft axis, comprises the medial border of the defect. (2) Fracture of the greater tuberosity. This is produced by impingement of the glenoid lip of the tuberosity. (3) Fracture of the inferoanterior lip of the glenoid. (4) Cystic changes in the head of the humerus. (5) Cystic changes in the region of the bicipital groove. The authors describe the roentgenologic technique they have developed for demonstrating this groove. The result is a tangential view of the shoulder in which a smooth notch is seen in the center of the humerus (the bicipital groove). On each side of the groove are prominent walls of the lesser and greater tuberosities.—*Mary Frances Vastine*.

ODGERS, S. L., and HARK, F. W. Habitual dislocation of the shoulder joint. *Surg., Gynec. & Obst.*, Aug., 1942, 75, 229-234.

Tears in the capsule of the shoulder joint under the subscapularis can be demonstrated in the dissecting room. Their location varies slightly, some being between the middle and inferior glenohumeral ligament, some between the glenoid ligament and the rim of the glenoid fossa, a few being humeralward to the inferior

glenoid ligament. This pathological picture is consistently found in the so-called direct force dislocation of the shoulder joint which is the forerunner of the habitually dislocating shoulder. Repair of this rent seems to be the proper treatment for preventing subsequent dislocations.—*Mary Frances Vastine*.

MOREL, MERVYN P. A case of spina bifida occulta of the 12th dorsal and 1st lumbar vertebrae. *Brit. J. Radiol.*, May, 1942, 15, 154.

A case of the above-named anomaly is described and illustrated with a roentgenogram. The patient was a young man, aged twenty-one, who complained of pain in the right lower abdomen. Appendectomy had been performed without relief. Deformity of the spine was found on examination and a roentgenogram showed spina bifida occulta of the twelfth dorsal and first lumbar vertebrae. There was also a spina bifida occulta of the fifth lumbar vertebra. As the pain did not interfere with the patient's work he was discharged.

This is a rare anomaly. Walker and Bucy examined 5,967 roentgenograms of the twelfth dorsal vertebra and 6,290 roentgenograms of the first lumbar and found spina bifida occulta once in each series. The condition apparently had no clinical significance in the above-described case.—*Audrey G. Morgan*.

CAMPBELL, R. J. C. A case of osteochondritis dissecans occurring in a young soldier accepted for military service. *Brit. J. Radiol.*, May, 1942, 15, 138-140.

A case of osteochondritis dissecans seen in Iceland in a soldier twenty-six years of age is described. He gave a history of having sprained his ankle some six years ago and at the same time the left knee was flexed under him. Some time later he began to complain of pain in the knee. Though he reported this knee complaint he was accepted for military service but since coming to Iceland has never been able to endure long marches.

The roentgen findings in this condition are characteristic. The roentgenogram of this case is given. It shows an oval shadow, denser if anything than the surrounding bone. This oval structure is surrounded by a narrow translucent zone of decalcified bone.

In these cases there may be separation of bone fragments, or joint mice, or separation

may not yet have occurred. If it has not immobilization and rest in bed should be tried for several weeks. If the fragment has separated operation is indicated.

The author believes this lesion is particularly well seen in the lateral view, while Liebman and Iseman believe it is best seen in the anteroposterior view and is apt to be overlooked entirely in the lateral view.—*Audrey G. Morgan.*

ROLLESTON, H., ORTON, G. H., and RUSS, S. The use of x rays in the manipulation of fractures of the extremities. *Brit. J. Radiol.*, Feb., 1942, 15, 63-64.

The taking of roentgenograms should be the usual means used in the examination of fractures but in exceptional cases the manipulation of such fractures under screen control may be necessary. This is a dangerous method for the surgeon at best and if he takes the risk he must do it on his own responsibility. Such work should be performed only by senior surgeons.

The operating room should be satisfactorily darkened. The previous roentgenograms of the case should have been seen and memorized, and not examined in the bright viewing box immediately before the manipulation. The apparatus should be operated by a technician who has had special training for this work, and he should keep a log book recording the factors with actual times of screening involved. The tube-screen distance should not be less than 20 nor more than 30 inches. The apparatus should not be set at more than 65 kv. and 2 ma. An automatic cut-out can be incorporated in the set which will cut out if these factors are exceeded. All apparatus should be shock-proof. An integrating time switch is useful. All exposures should be made with a timing device. The fluorescent screen, faced with lead glass, should be of modern manufacture and in good condition. The hands of the operator or his assistants must not come within the direct beam. The cryptoscope (a fluorescent screen fitted to the head and supplied with a hood) is very dangerous and should never be used.—*Audrey G. Morgan.*

SAMUEL, ERIC. Some minor injuries of bones and joints. *Brit. J. Radiol.*, March, 1942, 15, 77-84.

Young adults, particularly in military life, frequently suffer minor injuries of bones and joints, frequently repeated. It is important to recognize these injuries as some of them are

comparatively harmless and others may lead to serious disease in later life if not properly treated. Cases of a number of these injuries are described and illustrated with roentgenograms. The commonest minor lesion of bone is simple periostitis which can be differentiated from subperiosteal new growth by the fact that the cortex beneath it is unchanged. A second form of minor injury is myositis ossificans caused by tears in the periosteum. Injuries may be caused by a group of fractures variously known as insufficiency fracture, fatigue fracture or march fracture. These are frequently met with in army training.

The commonest minor injury to a joint is acute sprain. This is generally caused by a partial tear of one of the ligaments. The tear usually heals by fibrous tissue but sometimes calcification occurs at the site of the injury. It is important to differentiate between end-results, such as calcification, and the changes due to an active process such as osteochondritis dissecans. The latter is the commonest injury of joint cartilage. It is seen more frequently in the medial condyle of the knee than elsewhere. Oblique views of the knee joint should be taken when it is suspected and serial roentgenograms are also important. A rarer form of injury following minor trauma is avascular necrosis of a part of a bone, known as Panner's disease. Recurrent effusions into the knee joint may occur from damage to the menisci or cruciate ligaments. This results in thickening of the synovial membrane and disuse atrophy of the bones. This coarse atrophy can be differentiated from the fine homogeneous atrophy generally seen in tuberculous joints.—*Audrey G. Morgan.*

## ROENTGEN AND RADIUM THERAPY

ADAIR, FRANK E. Role of surgery and irradiation in cancer of the breast. *J. Am. M. Ass.*, Feb. 20, 1943, 121, 553-559.

Adair reviewed the operable cases of cancer of the breast seen at Memorial Hospital from 1920 to 1936, inclusive, of which there were 1,996.

For purposes of the study he determined to: (1) Evaluate radiation therapy as the sole agent in the cure of mammary cancer. (2) Evaluate radical surgery alone. (3) Evaluate the combination of preoperative irradiation together with radical surgery. (4) Evaluate the combination of immediate radical surgery and postoperative



irradiation. (5) Evaluate the combination of simple mastectomy with axillary irradiation.

All of the breast cases were classified as follows:

- I. Malignant tumors of the breast:
  - Carcinoma:
    1. Primary operable.
    2. Operable after a local excision.
    3. Primary inoperable.
    4. Recurrent inoperable.
    5. Prophylactic.
  - Sarcoma:
- II. Benign tumors of the breast.
- III. Lesions due to injury.
- IV. Inflammatory diseases of the breast.

Since 1933 the base of operability has been broadened. That is, many patients who were formerly considered totally inoperable are now being treated by combined surgery and irradiation, because investigation reveals that irradiation failed to cure them. It is now known that in mammary cancer, if there is much actual bulk to be handled by radiation therapy, it will fail.

For a period of six years every patient whose condition was operable was subjected to preliminary irradiation routinely without any suggestion of "selectivity." When one compares the results when patients are treated in this way with treatment by immediate radical mastectomy followed by irradiation a month or six weeks later, one finds that the cure rate is higher among those treated by the latter method. To the author's mind this phase of the controversial problem of the value of preoperative irradiation is definitely settled. He believes that one reason for the fact that cases treated by preoperative irradiation followed by surgery do not have as high a cure rate as those treated by immediate surgery and then postoperative irradiation is the loss of time necessary for the irradiation to be given. In all probability the good done by the preoperative irradiation is more than overcome by the loss of time resultant from delivering the dosage and waiting for the skin damage to repair.

The only criterion for effectiveness in therapy is the percentage of the total number salvaged. During the first five years, 1920 to 1924 inclusive, only 8 per cent of the total breast cancer material obtained a five year salvage. In explanation of this Adair suggests first that the patients are coming to the surgeon earlier in the course of their disease as a result of education

on the subject of cancer on the part of women. Second, as a result of coming earlier there is less bulk of axillary involvement with greatly increased opportunity for cure. Third, by experience we no longer are referring a patient with only a moderate opportunity for cure by surgery to the roentgen department, where there is less opportunity for cure. Fourth, the cure rate has gone up in those cases in which there is axillary involvement, because irradiation is here of decided value, particularly in groups 3 and 4 (on the malignancy scale). Not only does irradiation have a direct inhibitory effect on the remaining cancer cells; probably more important is the locking-up process of the cancer cells in the added scar and fibrous tissue as a result of irradiation.

In considering the amount of irradiation desirable as a postoperative procedure common sense should be our guide. A sufficient amount should be given to control the residual axillary disease and at the same time not enough to produce lymphedema of the arm. If there is a moderate amount of axillary involvement a total of 1,800 to 2,000 roentgens is given. If there is a large amount of axillary disease, with cancer spread over as far as the costoclavicular ligament 2,000 to 2,250 roentgens may be given.

In summarizing, the writer says this study shows that the preferable method of treating operable breast cancer is immediate radical mastectomy combined with postoperative irradiation. The poorest end-results obtained in this study were in those unselected cases given irradiation only.—*S. G. Henderson.*

KAPLAN, IRA I. Irradiation of the spleen and pituitary for control of puberal bleeding. *J. Am. M. Ass.*, April 10, 1943, 121, 1199-1201.

Kaplan states that an entirely unwarranted fear that irradiation may do harm to the generative organs is one of the main reasons why this well tested method is not more generally utilized in the treatment of irregular bleedings in young girls. When roentgen therapy is properly employed, permanent suppression of ovarian function and damage rarely occur. Streeter is quoted as saying that the more primordial the cells the more resistant they are to roentgen irradiation, whereas ova in the later stages of their differentiation are easily destroyed by roentgen irradiation, and the primordial cells which will produce their

successors are perhaps not so easily affected. Roentgen treatment that the patient receives may kill off all the follicles but in the course of time the primordial ovarian tissue produces new crops of eggs along with their accessory cells and this finally results in the resumption of menstruation.

Treatment over the spleen can be administered without much danger of affecting the ovaries, the indirect effect on the ovaries being considerably less than the supposed damage resulting from direct ovarian irradiation in young women and girls. In menorrhagia at puberty or just beyond this period, roentgen therapy to the spleen and on the pituitary can be safely administered without interfering with subsequent ability to bear children.

The author cites the case of a young woman suffering from irregular menstrual bleeding and hemorrhage for nine years, previously treated with medication without response. The condition was moderately controlled by roentgen therapy to the spleen and pituitary and she eventually resumed normal menstruation. She married at the age of twenty-two and gave birth to a perfectly normal child about two years later.—*S. G. Henderson.*

TAYLOR, HOWARD C., JR., and GREELEY, ARTHUR V. Factors influencing the end-results in carcinoma of the ovary; report of a series of 138 patients treated from 1910 to 1935. *Surg., Gynec. & Obst.*, May, 1942, 74, 928-934.

The authors reviewed 198 cases of ovarian tumor including 138 cancers of the ovary and 60 papillary cystadenomas. The principal factors which may vary the actual end-results as well as the figures as reported include:

1. *Gross Extent of Disease.* It is well recognized that the gross extent of the ovarian carcinoma at the time the operation is undertaken is the most important single consideration in prognosis.

2. *Types of Ovarian Tumor.* The granulosa cell tumors and dysgerminomas have a relatively favorable prognosis. In the largest group, the papillary serous and pseudomucinous adenocarcinomas, 88 in number, there was a five year cure rate of 15.9 per cent.

3. *Histological Degree of Malignancy.* The differentiated tumors of perhaps doubtful malignancy had a very much better prognosis than the others.

4. *Radiation Therapy.* Postoperative roentgen treatment of ovarian cancer was begun at the Roosevelt Hospital in 1928. For the first three years the therapy consisted in a single high voltage treatment given to each of four fields. From 1931 to 1933, four pelvic fields were treated, each receiving 670 r in one dose. From 1933 to the present time, four fields have been used, each receiving five exposures of 300 to 360 r at each treatment.

Postoperative roentgen therapy was apparently responsible for the five year cure of 2 cases in which recurrence was otherwise certain, but the effect of roentgen irradiation on the percentage of five year cures and on survival curves was less than has been frequently claimed.—*Mary Frances Vastine.*

DONOVAN, M. S., and WARREN, SHIELDS. Persistence of tumor after preoperative radium treatment for cancer of the corpus uteri. *Surg., Gynec. & Obst.*, June, 1942, 74, 1106-1111.

This work is summarized as follows:

1. Radiation therapy has won for itself an important place in the treatment of carcinoma of the body of the uterus. In the inoperable and technically operable groups of patients it is the only curative form of treatment available, and it provides about 10 per cent and 30 to 50 per cent five year survivals in these respective groups.

2. In the operable group of patients there has been a widespread opinion for some years that preoperative irradiation, chiefly by means of intrauterine radium, followed by hysterectomy and salpingo-oophorectomy one to two months later, would accomplish a higher percentage of cures than either irradiation or surgery alone. Accordingly, this has been advocated as the method of choice for treating this type of cancer.

3. More recent publications indicate doubt as to the wisdom of using preoperative radiation therapy as a routine measure in the operable cases. Good results have been obtained from a combination of surgery with postoperative roentgen irradiation.

4. Forty-six proved cases of carcinoma of the uterine body have been reviewed, all of which were treated by intrauterine radon and complete hysterectomy at least six weeks after the irradiation.

5. In only 5 cases was the uterus found to be free of carcinoma when removed.

6. This investigation does not throw light on the question of the value of irradiation in preventing vaginal metastases.

7. In deciding whether or not to use preoperative irradiation, the relative advantages of possibly destroying the tumor or decreasing its chance of implantation must be balanced against the delay and inconvenience to the patient.—*Mary Frances Vastine.*

CUTLER, MAX. Complications of radiotherapy in cancer of the cervix. *Surg., Gynec. & Obst.*, April, 1942, 74, 867-870.

The complications which may be met in the treatment of cancer of the cervix with radium and roentgen radiation include:

1. *Occlusion of the Cervical Canal.* Occlusion of the canal by the growth renders introduction of radium (which is the usual initial procedure) difficult and sometimes impossible. This difficulty can be obviated by initiating the treatment with external and vaginal irradiation. Regression of the lesion will follow so that the cervical canal can be located for insertion of radium without undue trauma and with no danger of perforation.

2. *Injury to Skin and Subcutaneous Tissues.* Early injury to the skin consists of an "epidermite" which expresses itself as a moist denuded surface caused by a complete loss of the superficial layers of the epidermis. Late skin injury consists of telangiectasis, atrophy and, in extreme cases, ulceration. The production of the "epidermite" should be avoided by protracting the total duration of treatment to five or six weeks and by adhering to the other principles of adequate filtration, limited surface areas, and low intensity.

Connective tissue damage, including injury to blood vessels, shows itself in the form of edema. This may appear within twenty-four hours of treatment or it may occur later during the irradiation. It is an indication for immediate reduction in the intensity of treatment.

3. *Injury to Blood.* The general apprehension regarding the dangers to the blood forming organs accompanying massive irradiation for cancer of the cervix is not supported by the most authentic evidence. All difficulties can be avoided by identifying the occasional patient with hypersensitivity to irradiation of the white blood cells.

4. *Injury to Bladder.* Serious damage to the bladder can occur only as a result of faulty irradiation.

5. *Injury to Rectum.* The rectal mucosa is one of the most radiosensitive tissues in the body. The first reaction is usually a watery diarrhea with two to four liquid stools daily, which comes on during the third week of external irradiation when a little less than half of the treatment has been completed (4,000 r or 150,000 mg-hr.). The only change in treatment required by this reaction is a reduction in the size of the skin field. If the rectal reaction becomes more severe, the daily dose must be reduced or the size of the field diminished or the treatment discontinued for several days or longer. A profuse, severe diarrhea accompanied by colic-like pain is due to overdosage and should be avoided.

6. *Late Post-irradiation Sclerosis of Pelvic Tissues.* Late sclerosis of the pelvic tissues may occur years after intensive irradiation for cancer of the cervix. This state may be accompanied by occlusion of the vagina and cervix followed by pyometra, vaginal sclerosis, rectal obstruction, and occlusion of the ureters followed by pyelonephrosis or pyelonephritis.

7. *Post-irradiation Intestinal Obstruction Resulting from Benign Stricture of Intestine.* This complication, although rare, is of the greatest importance. Unless it is considered, a diagnosis of recurrence is usually made. The clinical picture is classically that of intestinal obstruction.

8. *Localized Infection.* This may be divided into three groups: (a) early pyometra which appears toward the end or within several weeks after irradiation; (b) late pyometra which occurs from one to several years after treatment; (c) late infectious parametritis which arises one to three years after radiation treatment.

9. *Localized and Generalized Infection during Irradiation of Cervical Cancer.* Infection during the process of irradiation is by far the most important complication associated with the radiotherapy of cancer of the cervix, the 2 per cent mortality charged against this procedure being due almost exclusively to the activation of hemolytic streptococci by the irradiation. The incidence of hemolytic streptococci in cervical cancer is variously reported by different authors. Virulent hemolytic streptococci are probably less frequent in early lesions. A bacteriological examination should be made in every case before treatment as the infected cases re-

quire special attention.—*Mary Frances Vastine.*

SCHEFFEY, LEWIS C., THUDIUM, WILLIAM J., and FARELL, DAVID M. End results in the treatment of carcinoma of the cervix, 15-year report, 1921-1936. *Am. J. Obst. & Gynec.*, June, 1942, 43, 941-954.

Five and ten year end results obtained in the treatment of carcinoma of the cervix on the Gynecological Ward Service at Jefferson Medical College Hospital have already been published. This study adds 137 patients making a grand total for the fifteen year period of 293 patients seen and 277 treated with a follow-up figure of 97.2 per cent. Approximately 7 per cent of the lesions were classified histologically as adenocarcinoma, the remainder being squamous cell type.

*Extent of Involvement.* (1) 12 per cent were early cases; (2) 81 per cent were advanced cases; (3) 6 per cent had received primary treatment elsewhere.

These figures are discouraging for they would seem to show that patients seen with a relatively early lesion are comparatively rare.

*Age, Incidence, Parity, Race.* (1) 27 per cent of the patients exhibited cervical carcinoma before the age of forty; 57 per cent of the patients were between forty and fifty-nine years of age. The youngest patient was a twenty-two month old infant, the youngest adult was twenty-two and the oldest patient eighty-four; (2) 85 per cent of the patients were nulliparous; (3) 9.8 per cent of the patients were Negroes and 1.0 per cent were Jewish.

*Results of Treatment.* (1) The absolute salvage was 12.9 per cent (absolute salvage being the number of patients alive following treatment when the observation period is reported, based on the total number of patients actually seen). (2) The relative salvage was 13.7 per cent (relative salvage being the number of patients alive following treatment when the observation period is reported, based on the number of patients actually treated). (3) The five-year salvage was 23.1 per cent (the number of patients treated who have survived five years or longer but have eventually died of carcinoma, of an intercurrent condition, or of an entirely different malignant growth).

*Note:* The percentage of surviving patients who were over forty years of age when they received their initial treatment was about twice

as large as the corresponding percentage of survivors under forty.

*Treatment with Irradiation.* The patients treated with both radium and roentgen irradiation presented superior survival rates. There is some evidence in favor of the hypothesis that those patients receiving preliminary irradiation show a higher salvage rate.

*Carcinoma of the Cervical Stump.* The incidence of carcinoma of the cervical stump was 4.7 per cent. The results of treatment in cervical stump carcinoma have been better than with carcinoma of the cervix in general.

*Technique of Irradiation.*

*Radium:* The technique has changed over the fifteen year period. Since 1938 three 50 mg. capsules screened with 1.5 mm. of platinum intracervically placed and ten 10 mg. needles screened with 0.5 mm. of platinum interstitially placed have been used. From 1928 until 1936, 3,600 mg.-hr. was the dosage administered.

*Roentgen Rays:* Since 1938, two anterior and two posterior portals cross-firing on the uterus have been used. Two areas have been treated daily each receiving 200 r, measured in air. Treatments were continued until a well marked erythema was obtained (which will occur as a rule with a total of 1,600 to 2,400 r to each portal). Such a series requires about three weeks. Radium application has been delayed for two to three weeks following preliminary external irradiation.

*Histologic Grading and Prognosis.* The impracticability of attaching prognostic significance to the histologic grading of carcinomatous lesions of the cervix is noted.—*Mary Frances Vastine.*

## MISCELLANEOUS

MUNRO, DONALD, and ELKINS, CHARLES W. Two-needle oxygen myelography; new technique for visualization of spinal subarachnoid space. *Surg., Gynec. & Obst.*, Dec., 1942, 75, 729-736.

The authors have modified a technique for spinal air injections described by Chamberlain and Young in 1939. Instead of using a single needle, two needles are used and oxygen instead of air is employed as the medium for injection into the subarachnoid space.

One needle is placed low in the lumbar region and the other needle is placed at the desired cephalad level of fill. If the entire canal is to be visualized, the cephalad needle is placed in the

cisterna magna. As the patient's head is lowered, fluid will flow from the cephalad needle and as this occurs, oxygen is slowly injected into the caudal needle. It has been found that 20 to 30 cc. is sufficient to fill the lumbar area, 40 to 50 cc. the midthoracic and lumbar areas, and 75 to 100 cc. the entire spinal canal.—*Mary Frances Vastine.*

BOYD, DOUGLAS. A simple radiographic table for Smith-Petersen pinning of the femoral neck. *Brit. J. Radiol.*, 1942, 15, 94-95.

A table is described and illustrated which simplifies the taking of a lateral roentgenogram so necessary in pinning the neck of the femur. It is made of wood and any good joiner can make it. The body of the table is a heavy frame 4 feet long by 18 inches wide and 5 inches deep. The top is  $\frac{1}{4}$  inch plywood. The legs are screwed into heavy metal sockets. One end of the table projects to form a cassette tunnel. The perineal post which usually interferes with lateral roentgenography is replaced by webbing straps. The tractor mechanism permits of fixation and inversion of the feet. Abduction is obtained by sliding the whole leg assembly laterally in a semi-circle and this can be done because the point that rests on the floor is covered with rubber and does not slip. The unit can be dismantled and packed in the back of a car in a few minutes and transported for emergency use. There is no difficulty in keeping clear of the field of operation during roentgenography. The cassette tunnel enables the film to be slid into position from the safe side of the table.—*Audrey G. Morgan.*

HALBERSTAEDTER, L., and BACK, A. The effect of X rays on single colonies of *Pandorina*. *Brit. J. Radiol.*, April, 1942, 15, 124-128.

This article from the Hebrew University of Jerusalem describes work in irradiating single colonies of the green alga, *Pandorina morum*, which is found in the waters of Palestine. It was found that immediate death followed doses of 300,000 to 600,000 r. Different colonies have different sensitivity but all the daughter cells of a single colony are killed by approximately the same dose. Colonies irradiated with doses of 3,000 to 300,000 r do not die immediately but delayed death occurs at the time of mitosis. Doses of less than 3,000 to 4,000 r do not cause any change in the colonies. Tables are given

showing the details of the effects of single and fractional doses.

It has long been known that mitosis plays a prominent part in radiobiological reactions. The breakdown of irradiated cells at the time of mitosis also plays a part in the effects of irradiation on higher animals. It explains some therapeutic effects and delayed necrosis at long periods after irradiation.

While immediate death in *Pandorina* is only produced by extremely large doses, delayed death is caused by doses about 1/100 times as large and of a size similar to those used in the treatment of tumors in the human being.—*Audrey G. Morgan.*

GRAY, L. H., and READ, JOHN. The effect of ionizing radiations on the broad bean root. Part II. The lethal action of gamma-radiation. *Brit. J. Radiol.*, Feb., 1942, 15, 39-42.

Details of the technique of two methods of testing the lethal effect of gamma rays on broad bean roots are described and a table given showing the number and percentage of survivals by each method. The degree of agreement between the results of the two methods is not satisfactory. The data from the second method seem to be more reasonable than those from the first and the authors believe the results deduced from it are to be preferred. A graph is given showing the sigmoid mortality curve and the distribution curve of sensitivities based on the results of this method.

From the results of the experiments the authors conclude that it is unlikely that the difference in shape between the gamma-ray and neutron-ray mortality curves on which they have commented in earlier papers is real.—*Audrey G. Morgan.*

GRAY, L. H., and READ, JOHN. The effect of ionizing radiations on the broad bean root. Part III. The lethal action of neutron radiation. *Brit. J. Radiol.*, March, 1942, 15, 72-76.

This is one of a series of papers which record the results of a quantitative experimental study of one particular biological reaction to a variety of ionizing radiations. It compares the effect of neutron irradiation with gamma irradiation. The technique of the experiments is described and tables and curves given, together with the mathematical formulae used in the calculations. There is some uncertainty in the conversion

from ionization into energy units. Taking this into account the final result for the irradiation of beans by neutrons is: Mean lethal dose =  $75 \pm 16$  energy units. The comparable value for gamma rays is: Mean lethal dose =  $651 \pm 46$  energy units (or roentgens). The relative effectiveness of neutron and gamma ionization in causing the death of broad bean roots is therefore

$$\eta \frac{N}{\gamma} = \frac{\text{Mean lethal dose of } \gamma \text{ rays}}{\text{Mean lethal dose of neutrons}}$$

$$= \frac{651}{75} = 8.7 \pm 1.6.$$

—Audrey G. Morgan.

NEARY, G. J. The absorption of the primary beta radiation from radium in lead and platinum and the specific gamma-ray dose at a filtration of 0.5 mm. of platinum. *Brit. J. Radiol.*, April, 1942, 15, 104-109.

For many years it was believed that the primary beta radiation from a radium source was entirely absorbed by a filter of 0.5 mm. platinum, but during the course of some measurements made by the writer the question arose as to whether some of the primary beta radiation escaped unabsorbed from such a filter. He therefore decided to make a measurement of the effective range of the primary beta radiation in lead, as platinum was not available. The details of his experiments are described. He found that the range of beta radiation from radium in platinum is 0.53 mm. He found it very complicated to measure the primary beta radiation separately from the secondary beta radiation from the filter. But he concludes that for needles or flat applicators of 0.5 mm. platinum screenage the ionization of the primary beta radiation in the adjacent tissues is never more than a few per cent and in any case is much less than the ionization of the secondary beta radiation from the filter which has been investigated before.

The second part of the article deals with the measurement by the use of a graphite thimble chamber of the gamma-ray dose rate at 1 cm. from 1 mg. radium filter by 0.5 mm. platinum. The dose was found to be 8.4 e.s.u./cc./hr.—Audrey G. Morgan.

HERZ, R. H. A photoelectric instrument measuring quality and quantity of x rays for ra-

diographic purposes. *Brit. J. Radiol.*, April, 1942, 15, 110-113.

The photocurrent from a barrier layer photocell is proportional to the incident light within a certain range of intensity. Therefore such a cell can be used to measure the light emitted from a fluorescent screen and hence indirectly to measure the roentgen-ray intensity under certain conditions. The development of a new kind of roentgen-ray measuring device is based on the relationship between the photocell current and photographic effect. The apparatus is described and illustrated. It consists essentially of two barrier layer photocells placed side by side and facing a fluorescent screen but separated from it by a lead glass filter. Each cell is connected to a ballistic galvanometer. As the radiation reaching one of the cells is filtered through copper the deflection of this galvanometer by the rays will be less than that of the other. Every change of roentgen-ray quality will change the ratio of the two galvanometer deflections. A special ratio meter has been devised to measure the ratio of the two galvanometer deflections. It is described and illustrated. With this meter the roentgen-ray quality and the photographically effective dosage can be measured with one deflection of a spot of light. A chart is given showing the values of the quality of roentgen rays as determined in this way. This method can be used with different types of generators. By including a calibrated photocell dosimeter on a roentgen-ray switchboard a basis for the standardization of roentgenographic values is obtained and at the same time instantaneous readings of quality (with various filters) and quantity.—Audrey G. Morgan.

SMITHERS, D. WALDRON. The spatial distribution of x rays and total energy absorption: a consideration of the importance of these concepts in the x-ray treatment of cancer. *Brit. J. Radiol.*, Feb., 1942, 15, 50-55.

In the treatment of deep cancer the rays must penetrate normal tissues to reach the cancer. Because of the decrease of dose with depth the normal tissues will be given a larger dose than the tumor unless multiple beams are used which overlap in the deep tissues so as to raise the dose to the tumor region. The chances for cure are best in localized tumors but their radiosensitivity is about the same as that of the

normal tissues. Every effort must be made to localize the large dose to the tumor and the total volume given a high dose must be kept as small as possible. Every device must also be used to increase the sensitivity of the tumor cells as compared to that of the normal cells around them.

In the past the dosage factors that have been considered of chief importance were: dose at the skin, tumor dose, quality of the primary radiation, dosage rate on the skin, time spacing of the treatment. Increasing emphasis has been placed lately on the maximum and minimum doses to the region involved and the development of methods of studying the distribution of radiation throughout the whole volume treated. In the past too much stress has been laid on skin tolerance and too little on the tolerance of the patient. The severe effects of irradiation and the tumor response are both related to the volume of tissue that is given a large dose. The damage to a tumor depends not only on the dosage given the tumor but on the changes produced in the surrounding tissues. The total energy absorbed has a profound effect on the dose that can be given a tumor and the effect on the tumor. Up until recently there has been no method of measuring the total energy absorbed throughout the body of the patient. It has now been found that the total energy absorbed can be estimated by a suitable extension of the system of dosage based on the international unit of dosage, the roentgen, combined with a consideration of the volume of tissue irradiated.

The roentgen is a measure of the energy absorbed by one gram of air and also a measure of the amount of energy absorbed per gram of soft tissue. The energy absorbed when one roentgen is given to one gram of tissue is one gram-roentgen. If for instance a dose of one roentgen is given to 10 cc. of tissue the integral dose is 10 gram-roentgens or if a dose of 6,000 r is given to 1,000 cc. the integral dose is 6,000  $\times$  1,000 =  $6 \times 10^6$  gram-roentgens, or 6 megagram-roentgens. The integral dose, that is the total body absorption, is found to vary greatly

with the different treatment techniques. The statement that a patient has been given an integral dose of 5 megagram-roentgens should soon be as familiar as saying that a patient has been given 5,000 r.

The practice of directing several roentgen-ray beams at the center of the tumor is seldom the best arrangement. The determination of the volume distribution due to several angled fields is long and cannot be applied to each patient. It is used to decide the best arrangement in standard techniques. These arrangements ensure that the largest dose is limited to the tumor. Much of the value of the determination of volume distributions is lost if the beams are not directed accurately. Accurate beam direction can be assured by the use of such devices as those described by Mayneord and Dobbie.

A graph is given showing the treatment given one patient that shows the above-named factors. The maximum and minimum doses to the tumor are determined from the complete volume distribution. The graph shows the curve of the dose with time.—*Audrey G. Morgan.*

Cook, H. F. Note on the skin-dose measurement of radium moulds: gamma-ray back-scatter. *Brit. J. Radiol.*, 1942, 15, 48-49.

A simple technique is described for measuring the back-scatter for increasing irradiated areas. To get the true dosage rate at the surface of a radium mould in position on a patient a correction for back-scatter from the mould must be made on the dosage rate as measured in air. The correction, which increases at first for the size of the area irradiated becomes constant at 6 per cent for areas greater than 100 sq. cm. A table is given showing the percentage increase in back-scatter and a curve showing the percentage increase in dose due to back-scatter plotted against area. The percentage back-scatter does not vary with varying radium-skin distances. Measurements at points other than the center of the irradiated area showed that the back-scatter was fairly uniform over the area, falling off only at the edge.—*Audrey G. Morgan.*





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## EFFECT OF ROENTGEN RAYS ON THE MINUTE VESSELS OF THE SKIN IN MAN\*

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IT HAS been recognized for some time that vascular changes (immediate and permanent) may develop after roentgen irradiation. It has seemed to us that too little attention has been directed to the study of the immediate reactions and the influence they may exercise.

Pohle,<sup>1,2,3</sup> one of the few investigators interested in this subject, and Pohle and Bunting<sup>4,5</sup> have described the effect of various types of roentgen rays upon the capillaries of the skin in man and rats. Their observations were that roentgen exposures caused an increase in the number of capillaries, as seen through the capillary microscope. Pohle did not, however, differentiate between capillaries and branches of the subpapillary venous plexus. Moreover, he used the flexor surface of the forearm, where the subpapillary venous plexus is more conspicuous than on the extensor surface, and where it interferes considerably with recording accurate capillary counts.

The present report will record our observations on the minute vessels of the skin in man made following exposure to roent-

gen rays. Even though the problem as originally conceived could not be completed because of the exigencies created by the war, the observations made thus far seem significant and are presented as a preliminary report with the hope that others may feel that the problem merits further investigation.

### METHOD

Roberts and Griffith,<sup>6</sup> and later Griffith, Roberts and Corbit<sup>7</sup> developed a method for following changes in visible cutaneous capillaries which allows one to express results in a rough quantitative manner. They consider the capillaries not in terms of the actual number open and visible, but in terms of the proportion these represent of the total capillaries in that area. The total capillary number is obtained by counting the area after pricking 1:1000 histamine nearby, so that the area under observation is included in the flare. If no change in capillary count is observed after histamine, it is believed that all of the capillaries were open initially. Such an area could not be expected to show an increase in count under any conditions.

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† Atwater Kent Fellow in Medicine.



The experimental period included the winter and early spring, but not the warm weather of late spring and summer. The subjects, 84 in number, were adult white patients from the wards of the University Hospital. All were ambulatory, free of demonstrable skin disease, and not in circulatory failure. About 9 A.M., after breakfast, they reported to the laboratory for the capillary counts.

The skin areas studied were on the extensor surface of the forearm, midway between the wrist and elbow, because experience showed that accuracy of the capillary counts was greatest there. The forearm was placed approximately at the level of the lower portion of the sternum to avoid the hypostatic movement of venous pressure. Two areas of about 2 sq. mm. and 4 inches apart were marked on each forearm by inking a circular die and pressing it gently on the skin. The exact area varied somewhat with the tension and elasticity of the skin and the tendency of the ink to run slightly, but, once marked, was constant for the duration of the experiment. Each circle was covered with cedar oil and observed through a microscope with an "Ultrapak" attachment. The capillaries in the marked area were counted and the visibility or nonvisibility of the subpapillary venous plexus noted. When hairs interfered they were clipped with scissors or with a razor held away from the skin surface. The marked areas were protected from trauma by encircling them with "corn pads."

The patients were then sent to the Department of Radiology where one forearm was irradiated and one left untreated as a control.\* The total amount of radiation delivered to each patient was approximately the same. The rate of administration and the wave length of the radiation varied. This exposure was begun about 10 A.M. and completed shortly thereafter. At

4 o'clock (six hours later) the capillaries were again counted and the appearance of the field noted. This was repeated at 9 o'clock the following morning. The corn pads were then removed and a drop of histamine, 1:1000, was pricked into the skin with a needle near the area, so that the flare included the region that had been previously studied. At this time a final count was made.

The number of capillaries open and visible after histamine was considered to be 100 per cent of the visible capillaries in the field. The number of capillaries visible at any other observation was expressed as a percentage of this total number. Percentage changes between two counts were obtained by simple addition or subtraction. The percentage change after irradiation was expressed in the capillary count between a treated area and the average of the control areas in the same patient (see the ordinates of Figure 1).

An example may aid in making this clear: Suppose, in a treated area, the capillary count before treatment was 10; five hours after treatment, 18; twenty-four hours later, 12; and after histamine, 20. Thus 20 represents 100 per cent of the capillaries. Therefore 50 per cent were open before treatment, 90 per cent five hours after treatment, and 60 per cent twenty-four hours after treatment. Thus the absolute increase in five hours was 40 per cent, and in twenty-four hours, 10 per cent. But the two control areas showed initial counts of 8 and 12; at five hours 10 and 14; at twenty-four hours 6 and 8, while the counts after histamine were 16 and 20. Thus the control areas had 50 and 60 per cent of their capillaries open originally. After five hours they showed a rise each to 62 and 70 per cent, a gain of 12 and 10 per cent, the average gain being 11. Thus the net increase in the treated area is 40 less 11, which equals 29 per cent. Similarly calculated, the net increase in the treated area in twenty-four hours, when the control change from the initial count averaged minus 16.5, is 10 plus 16.5 which equals 26.5 per cent.

\* In an initial series in a score of subjects it was found impracticable to treat with different quantities of radiation or to leave untreated as controls different areas in the same forearm. The lymphatic system of this limb is so rich that injury in one region will affect the capillary counts in others at a considerable distance.

Subjects listed include only those having an initial capillary count of less than 75 per cent of the total number, and in whom technical breaks did not occur. For example, some patients got water on the areas and disturbed the ink markings. Others, for various reasons, were not available for the twenty-four hour count. All these are excluded.

The subpapillary venous plexus was described as being present in those cases in which it was absent before treatment and visible after treatment only in the treated areas and not in the controls.

#### ROENTGEN EXPOSURE

The patients were divided into four groups, depending upon the physical characteristics of the radiation employed (Fig. 1).

*Group I.* These patients were irradiated by a Villard type generator, operating at 200 kv. (peak) and 20 ma. The inherent filtration of the oil-immersed tube was equivalent to 0.25 mm. copper. The added filtration was 0.50 mm. copper plus 2.0 mm. aluminum. The target-skin distance was 15 cm. The short distance was chosen to obtain a roentgen-ray beam of high intensity. With these factors the output of the tube was 444 r per minute, measured in air.

The area irradiated was approximately 2 sq. cm. The total amount of radiation delivered to the skin surface at one sitting was 333 roentgens, measured in air.

*Group II.* The physical characteristics of the rays used in this group were exactly the same as those employed in Group I. The target-skin distance, however, was 50 cm. At this distance the tube output was 42 r per minute, measured in air.

The area irradiated was approximately 2 sq. cm. The total amount of radiation delivered to the skin surface at one sitting was 301 r, measured in air.

*Group III.* The physical characteristics of the rays used in this group were exactly the same as those employed in Groups I and II, with the exception that the current

was reduced to 5 ma. in order to reduce the output of the tube at 50 cm. target-skin distance. Under these conditions the tube output at 50 cm. was 10 r per minute, measured in air.

*Group IV.* These patients were irradiated by a Chaoul contact therapy apparatus, operating at 50 kv. (peak) and 4 ma. The filtration employed was 0.2 mm. of nickel,

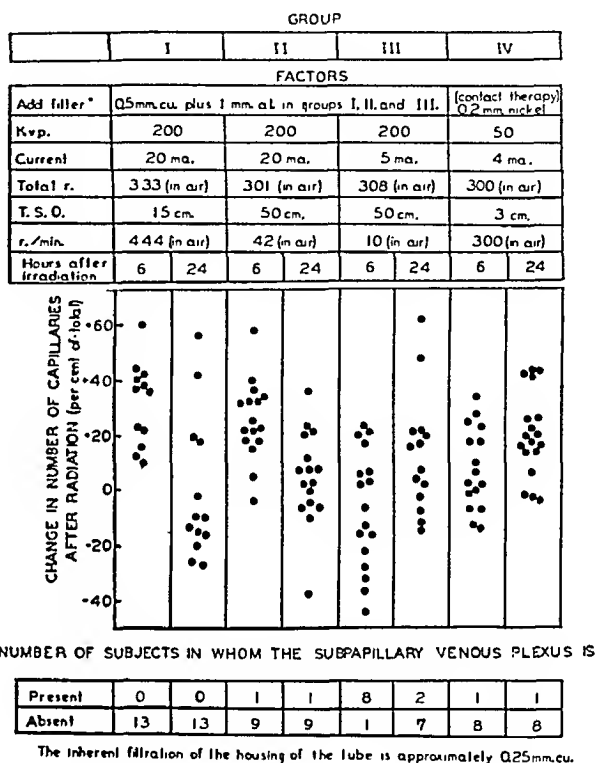


FIG. 1. Chart showing the effect of roentgen rays on cutaneous capillaries under varied conditions. For details see text.

inherent. The half-value layer was 2.4 mm. aluminum. The target-skin distance was 3 cm. The output of the tube at this distance was 300 r, measured in air.

The area irradiated was approximately 2 sq. cm. The total amount of radiation delivered to the skin surface at one sitting was 300 r, measured in air.

It is noteworthy that the patients in Groups I, II and III were all irradiated by the same machine. The small variations in tube output for the different groups may be attributed to our adherence to the calibration data of the roentgen tube.

# SKIN CAPILLARIES AND SUBPAPILLARY VENOUS PLEXUS

The normal appearance of the vessels of the skin of the extensor surface of the forearm is shown in Figure 2. The capillaries

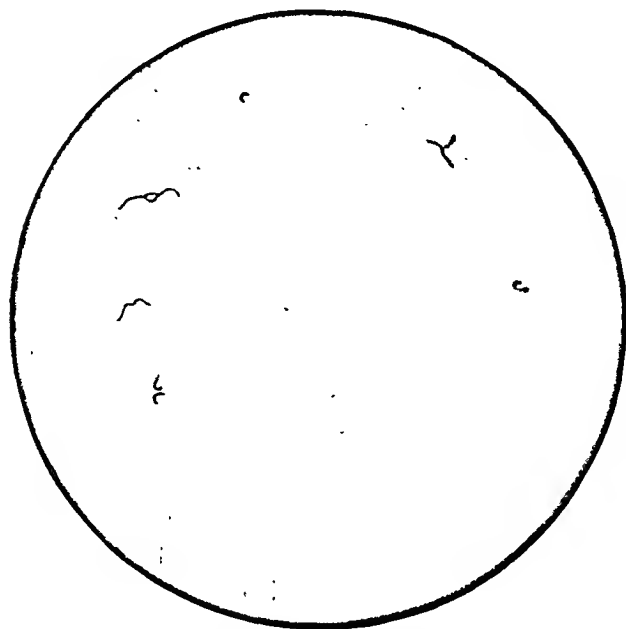


FIG. 2. Appearance of the capillaries and subpapillary venous plexus in the normal skin of the extensor surface of the forearm. Camera lucida drawing in natural colors.

show only at their tips, where they appear as short arcs or red "commas," while the subpapillary plexus shows as somewhat longer vessels following a more varied course. The general color of the background of the skin is yellow. Figure 3 shows the same area after maximal vascular dilatation.\* The same vessels can still be described but many more have been added, both capillaries and venous plexus. In fact, the vessels of the plexus are so numerous that an accurate count of the capillary tips is difficult. The general background is red. Both drawings were made using the camera lucida. The procedure was too long to record the more transient vascular change following histamine.

\* Maximal dilatation was produced and maintained by burning the skin nearby with a red-hot glass rod. This was repeated several times at various points around the area of observation. Dilatation by histamine is not maintained long enough to make such a drawing.

## RESULTS

In Group I (333 r delivered in  $\frac{3}{4}$  minute at 200 kv. (peak), 15 cm. target-skin distance) a significant dilating effect on the skin capillaries was observed after six hours, which was largely gone after twenty-four hours (Fig. 1).

In Group II (301 r delivered in 7.2 minutes at 200 kv. (peak), 50 cm. target-skin distance) a distinct dilating effect was observed six hours after exposure which was still present, but to a lesser degree, at the end of twenty-four hours (Fig. 1).

In Group III (308 r delivered in 30.8 minutes at 200 kv. (peak), 50 cm. target-skin distance) there was no significant change seen in the skin capillaries after six hours and no very definite effect in twenty-four hours.

In Group IV (300 r delivered in 1 minute at 50 kv. (peak), 3 cm. target-skin distance) a moderate capillary effect was observed at the end of six hours which became more marked after twenty-four hours.

The responses of the subpapillary venous plexus to irradiation were also observed and recorded. It is noteworthy that Group III,

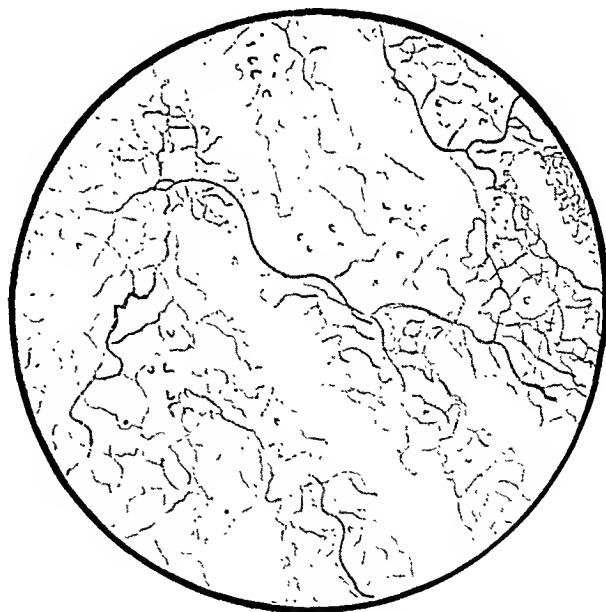


FIG. 3. Appearance of the capillaries and subpapillary venous plexus in the skin of the extensor surface of the forearm after maximal dilatation following a burn. Camera lucida drawing in natural colors.

which showed the least effect on the capillaries, showed the greatest effect upon the subpapillary venous plexus. The significance of this observation is uncertain. However, some suggestions may be offered.

The blood supply of the skin serves a double purpose: (1) it supplies the metabolic needs of the skin and (2) it acts as a vector to dissipate heat from the body as a whole. This first function is supplied mainly by the true capillaries, in which blood flows slowly from the subpapillary arteriolar plexus to the subpapillary venous plexus. As the metabolic needs of the skin are ordinarily small, under normal conditions many of the capillaries do not contain blood and, in some, which do contain red cells, there is no flow. From time to time this situation will change, in that flow will begin in "resting" capillaries and cease in others which had been active.

Much more blood is contained in the subpapillary venous plexus than in the true capillaries of the skin; in fact, it is the blood in the venous plexus which accounts for most of the color of the skin. Only a portion of this blood reaches the venous plexus by way of the capillaries, the greater part passing through the so-called arteriovenous anastomoses. These structures are larger than true capillaries, pursue a much shorter course, lie more deeply, and are well equipped with nerve fibers. They can open or close very quickly, thus admitting or excluding arterial blood from the venous plexus. When all, or nearly all, the arteriovenous anastomoses are open in a given cutaneous area the result is the so-called "capillary pulse," which is really a venous pulse, as blood is admitted with each systole into the subpapillary venous plexus. It is seen especially in subjects with aortic regurgitation or hyperthyroidism, but can be induced in a normal subject by placing the hand in warm water. Arteriovenous anastomoses tend to be open in those conditions necessitating increased heat elimination.

The true cutaneous capillary begins in the subpapillary arteriolar plexus and ends

in the subpapillary venous plexus. It thus, at its terminations, lies at the same level as these plexuses and the arteriovenous anastomoses. However, it lies more superficially through the greater part of its course, as it passes to and then away from the skin edge. Thus, if one regards the cutaneous vascular system as consisting of the true capillaries and the subpapillary venous plexus with the arteriovenous anastomoses, which differ from each other both functionally and anatomically, it is not surprising that this complex system varies in its response to stimuli. Whether, for the type of stimuli considered, the difference is due to the amount or depth of injury, or to a neurotropic effect on the arteriovenous anastomoses, is not known at this time.

#### SUMMARY

Differences in the responses of skin capillaries and subpapillary venous plexuses to irradiation have been observed in man. These seem related to the method of irradiation.

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# DETERMINATION OF THE PLACENTAL SITE IN BLEEDING DURING THE LAST TRIMESTER OF PREGNANCY

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**B**LEEDING in the last trimester of pregnancy frequently indicates placenta previa, or a premature separation of the placenta. In placenta previa a sterile vaginal examination will disclose to the examining finger a boggy mass covering the uterine canal, while in the presence of a negative examination, a premature separation of the placenta should be considered. The vaginal examination, however, has two limitations: (1) a marginal placenta may be beyond reach of the examining finger and yet at delivery may be found to be the cause of severe bleeding; (2) the cervix is not always patulous at this time, because as shown by Ude, Urner and Robbins,<sup>32</sup> the average duration of pregnancy in placenta previa is 252.7 days. When the cervix is not patulous, according to Stander,<sup>28</sup> it is not justifiable to dilate it for this purpose. As a result of these limitations, the existence of a placenta previa cannot always be excluded. Since the maternal mortality in placenta previa, as reported by leading authorities, varies from 1 to 10 per cent, uterine bleeding is always a source of anxiety to the obstetrician. Consequently, any method of determining more accurately the placental site in the last trimester of pregnancy is a welcome addition to the diagnostic armamentarium.

The technique of placental visualization by means of the roentgen rays has been evolved over a number of years. One of the earliest methods recommended was that of amniography by Menees, Miller and Holly<sup>22</sup> in 1930. A water soluble solution of strontium iodide was injected directly into the placental sac through the anterior abdominal wall. The opaque medium mixed with the amniotic fluid so that upon roentgeno-

graphic examination the placenta could be visualized within the uterine cavity. The method was found to give satisfactory results in both animals and humans. These authors, with Campbell,<sup>7</sup> made the interesting observation that the fetus swallows the amniotic fluid, with the result that the opaque medium could be seen in the stomach and intestines of the fetus. The method was then used by Kerr and Mackay<sup>19</sup> in 1934, who, following the death of three fetuses, substituted uroselectan B. They found this had a tendency to terminate the pregnancy, but as long as the fetus was viable this was not a serious drawback. The following year a report was made by Burke,<sup>5</sup> who also used uroselectan B. He was able to establish the correct diagnosis in 15 of 23 cases, but in his series he found that the technique caused the patient to go into labor. As a result, he used it as a method of inducing labor, with good results. A series of 6 cases, in which amniography was used, was studied by Cornell and Case.<sup>10</sup> The radiopaque medium, neoskiodan, gave effective contrast, but each placenta was punctured in entering the uterus, with great danger of entering a fetal blood vessel and of subsequent fatal hemorrhage. Unqualifiedly, they advocated the discontinuance of this method because of its inherent dangers. This was the position taken by the medical profession, and amniography was little used, while more accurate and less dangerous methods of placental visualization were introduced.

Before this time, two other methods had been tried with little success. Hewitt<sup>16</sup> is said to have injected lipiodol directly into the placental site but visualization was unsatisfactory. Ehrhardt<sup>13</sup> had injected thoro-

trast into experimental animals and found that the material was picked up by the reticulo-endothelial system of the liver, spleen and placenta. The known dangers of radioactive thorium dioxide discouraged further investigation of this method.

In 1934, Ude, Weum and Urner<sup>31</sup> reported a case of placenta previa diagnosed by the interposition of a soft tissue mass between the fetal head and the bladder, after the injection of opaque material into the bladder. At the same time, they reported 2 other cases of placental visualization. In a later paper, Ude and Urner<sup>30</sup> called attention to the fact that the roentgenologist must be prepared to differentiate a small part of the fetus, such as a hand or a blood clot in the lower uterine segment. These preliminary reports were followed by others more enthusiastic as knowledge of the procedure spread to other clinics. McIver<sup>21</sup> noted that the method carried with it no danger of provoking hemorrhage or introducing infection, and reported 8 cases, all of which were correctly diagnosed, and suggested its wider use by the general practitioner. However, McDowell<sup>20</sup> was able to make a correct diagnosis in only 7 out of 9 cases, using the same technique. Hall, Currin and Lynch<sup>15</sup> studied 40 cases of bleeding in the last trimester of pregnancy. With the exception of 5 cases of breech presentation, all of these cases were correctly diagnosed as to the placental site. This led them to the conclusion that cystography was of value in determining the method of procedure in abdominal or vaginal delivery. Others who reported good results were Prentiss and Tucker<sup>23</sup> with an accuracy of 80 per cent, and Beck and Light<sup>3</sup> who made the correct diagnosis in 88.7 per cent of 71 cases. Air as a means of contrast was used by Prentiss and Tucker<sup>23</sup> who found it to be superior to sodium iodide. In a later report, Ude, Urner and Robbins,<sup>32</sup> the originators of the method of cystography, reported a study of 15 cases. The average distance between the fetal skull and the wall of the bladder was 1 cm. The central type of placenta previa was noted to displace the pre-

senting part upward over the entire upper surface of the bladder, while the partial type was seen as a tendency to depress one of the lateral horns of the bladder and displace the fetal parts to the opposite side. In 44 cases their accuracy was 98 per cent. Friedman and Macdonald<sup>14</sup> reported 2 verified cases of placenta previa with roentgen findings. The lowest percentage of accuracy was that of Carvalho<sup>9</sup> who correctly diagnosed only 13 out of 19 cases of placenta previa. In all the cases where the placenta was not seen by means of a cystogram, the placenta was found implanted on the posterior wall with only the margin or one or two cotyledons overhanging the os. This factor proved to be one of the drawbacks of this method and was emphasized by Dippel and Brown<sup>11</sup> who called attention to the fact that training and experience were needed in interpreting these roentgenograms. It also led Holmes,<sup>17</sup> in a review of the literature, to conclude that it had only a fair degree of accuracy. Arnell and Guerriero,<sup>1</sup> although making no report of their cases or technique of examination, found the cystographic method of diagnosis of little value in placenta previa.

In 1934 Snow and Powell<sup>25</sup> called attention to the fact that the placenta could sometimes be visualized in the lateral view of the abdomen during the last trimester. They reported one case in which the findings were verified at autopsy. To their credit belongs the discovery of the value of direct roentgen visualization of the placenta in cases of possible placenta previa. The study of a soft tissue technique was advanced by Carty<sup>8</sup> who advised the use of: (1) 300 ma-sec.; (2) 36 inch distance; (3) voltage to vary with thickness; (4) intensifying screens and development by sight. In the hands of Snow and Rosensohn<sup>26</sup> it was found possible to demonstrate, in addition to the placental site, polyhydramnios, placental apoplexy and extra-uterine pregnancy by this method. Later, Weintraub and Snow<sup>34</sup> showed that the black line of demarcation seen between the fetus and overlying uterine wall was entirely due to

fetal subcutaneous fat and not to the vernix caseosa. With this technique, Dippel and Brown<sup>12</sup> were able to demonstrate the placenta in 90 per cent of 203 observations. Non-visualization, they found to be due to: (1) hydramnios; (2) twins; (3) immaturity; (4) obesity. Unsatisfactory roentgenograms accounted for 3 per cent. As far as the position of the placenta was concerned, no error was found in 53 cases checked by clinical methods. In a later paper these authors<sup>11</sup>

duced the use of a plastic filter in order to allow the usual amount of radiation to the anterior portion of the abdomen, while the heaviest radiation strikes the region of the pelvis and spine. This method promises to further increase the diagnostic value of the soft tissue technique.

A study of our results during the past four years at the University of Maryland Hospital was made in order to determine the relative value of the roentgen examina-

TABLE I

Roentgen Diagnosis	No.	Clinical Diagnosis	No.	Delivery	No.
A. Placenta previa	2	Central placenta previa	2	Cesarean	2
B. Marginal placenta previa	2	Partial placenta previa	1	Cesarean	1
		Undetermined (i.e. cause of bleeding)	1	Vaginal	1
C. Low implantation (possible marginal)	25	Partial placenta previa	2	Cesarean	2
		Marginal placenta previa	4	Cesarean	2
				Vaginal	2
		Low implantation with partial separation	5	Decapitation and extraction	1
				Vaginal	4
		Low implantation	4	Vaginal	4
		Cervical erosion	4	Vaginal	4
		Undetermined	6	Vaginal	6
D. Negative for placenta previa	101	Negative for placenta previa	98	Vaginal	98
		Possible marginal placenta previa	1	Vaginal	1
		Partial placenta previa	1	Version and Extraction	1
		Central placenta previa	1	Cesarean	1
E. Unknown	2	Partial placenta previa with twins	1	Cesarean	1
		Partial placenta previa with profuse bleeding	1	Willett forceps	1
				Voorhees bag	

noted that presentation of the fetus should not interfere with the identification of the placenta. We have been able to substantiate this in our series. With this same technique, Buxton, Hunt and Potter<sup>6</sup> were able to localize the placenta in 86.1 per cent of 108 cases. When the placenta was not visualized in the fundus, a cystogram was done using 4 per cent sodium iodide as a contrast medium. With the combined methods, they were able to localize the placenta in 97.6 per cent of cases. There were 17 cases of placenta previa in which the diagnosis was made accurately in 16. Recently, Vaughan, Weaver and Adamson<sup>33</sup> intro-

tion. During the period from November 1, 1938 to February 1, 1943, a total of 132 cases were examined. The bleeding varied in amount from an occasional spotting to the passage of large blood clots. These cases were not selected and all were examined by the method to be described, with the following results and clinical course of pregnancy (Table 1).

It will be seen that in making a positive diagnosis of placenta previa, Group A and B, we were correct in 3 out of 4 cases, or 75 per cent. We are unable to explain the case which was misdiagnosed, as the placenta was present on the anterior uterine



wall and appeared to extend down to and over the internal cervical os. A sterile pelvic examination before delivery and an examination of the placenta after delivery failed to reveal the cause of the bleeding. With more experience in interpretation, we expect our average in this group to improve.

In our reports we have come to consider a low implanted placenta as being a possible marginal placenta previa, Group C. Until some further refinement of technique is made, we do not feel safe in attempting to differentiate between a low implantation of the placenta and a marginal placenta previa. The shape and size of the placenta have a wide range of normal values. In addition to that, the possibility of abnormality of implantation as suggested by Brown and Dippel<sup>4</sup> must be considered, such as a placenta succenturiata, bipartita and spuria. In this group, considering the cases of cervical erosion and bleeding of undetermined causes to have been misdiagnosed, our accuracy was 60 per cent (15 out of 25 correct). These cases were all examined vaginally, both bimanually and by speculum, subsequent to roentgen examination. Then, depending upon the clinical judgment of the obstetrician, the fetus was delivered by vagina or by laparotomy. At the time of section, an attempt was made to determine the location and extent of the placenta and this was noted on the chart. A number of cases delivered by vagina had an amniorhexis performed. After delivery of the placenta, the distance between the incision and the nearest border of the placenta was measured. Consequently, the clinical diagnoses in Group C are very accurate and we were able to make an exact comparison with our roentgen findings. The high number of cases of partial separation, associated with a low implantation of the placenta, has been explained by Torpin.<sup>29</sup> In a study of 144 placentas, he found that there is frequently a rupture of a large decidual vessel when the excess ring of chorionic villi is folded back from the uterine wall to form the infarct ring of placenta marginata.

In Group D, the roentgen method of placenta previa diagnosis was shown to be most accurate: 98 out of 101 cases were diagnosed correctly for an average of 97 per cent. This is in accordance with the view of Beck and Light<sup>3</sup> who found that the method had its greatest value in ruling out placenta previa as a cause of vaginal bleeding. An analysis of our 3 failures showed: (1) One case to have been diagnosed clinically as a possible placenta previa but this was never clearly demonstrated either before or after delivery. (2) In the second patient the placenta was implanted on the mid-portion of the posterior uterine wall. Despite the fact that the bladder was deviated laterally, this was diagnosed as negative. Vaginal examination showed it to be a partial placenta previa. (3) The third case was grossly misdiagnosed. Re-study of the roentgenogram indicated a definite placenta previa.

Only 2 cases are included in Group E. This is a very low number and indicates that the method is readily applicable to various anomalies of position and presentation of the fetus. These 2 cases, of course, must be considered as failures: (1) One case was that of twins at term, but with no fetal parts entering the pelvis. Despite adequate technique we could not demonstrate the placenta. (2) The second case was that of a young mother admitted with profuse bleeding. The examination was not completed because the patient was on the threshold of shock, consequently we were unable to make a diagnosis.

For the entire group of 132 patients, we have made the correct diagnosis in 87.8 per cent of the cases. Our best results were in making a negative diagnosis in which we were 97 per cent correct. This is important because the obstetrician can then safely allow these patients to go to term and deliver vaginally, without undue fear of a sudden fatal hemorrhage from a placenta previa. Our poorest results were in the diagnosis of low implant and possible marginal placenta previa, with only 60 per cent correct diagnoses; however, to be fore-



warned is to be forearmed. Those relatively few patients out of this group whose diagnosis is not confirmed or disproved by vaginal examination can be placed under strict supervision, so that any untoward development can be handled. Vaughan, Weaver and Adamson<sup>33</sup> point out that in addition to diagnosing placenta previa, the method is of value in that it is possible (1) to demonstrate placenta previa before serious bleeding begins; (2) to know the exact site of the placenta if it becomes necessary to do a cesarean section; (3) to know presentation and position. However, we do not agree with the above authors that vaginal examination may be avoided by this method. Rather, it is an accessory to the vaginal examination and is not intended to supplant the latter. Heed should be paid to the warning of Carvalho<sup>9</sup> that all patients who have a history of bleeding should receive the benefit of a careful vaginal examination under proper precautions. Again, it is only logical that even though a placenta previa be ruled out, the presence of a premature separation or a cervical erosion should be looked for and treated if necessary.

*Technique of Examination at the University of Maryland Hospital.* All dispensary and private patients are referred to the hospital for admission whenever they report bleeding in the last trimester of pregnancy. If the bleeding is not too severe, the first step is the roentgen examination. All patients are treated as emergencies. As soon as possible, even before the processing of the films is completed, a tentative diagnosis is given to the physician in charge of the patient.

Routinely, two large roentgenograms are taken of the abdomen, in the lateral and anteroposterior positions. It has been stated by Dippel and Brown<sup>11</sup> that a single lateral view will suffice. In the majority of cases this is true, as regards placenta visualization, but in a certain number of cases various pathological conditions in mother or child are apt to be overlooked in the single film technique. In 2 of our cases, the placenta was not visualized in the lat-

eral position but was shown in the anteroposterior view. In addition to this, we have been able to show cholelithiasis, nephrolithiasis, intestinal obstruction, uterine tumor, extra-uterine pregnancy, cephalopelvic disproportion and fetal death as complications of pregnancy in our routine examinations. Also, the exact position and presentation of the fetus is then known, factors which are sometimes of great value in the subsequent treatment.

The technical factors used in our soft tissue examinations are as follows: (1) 300 ma-sec.; (2) 36 inch distance; (3) intensifying screen; (4) Potter-Bucky diaphragm; (5) kilovoltage varies with thickness of the patient; (6) removal of all filtration. This is essentially the original technique recommended by Snow and Powell.<sup>25</sup> The kilovoltage is usually 65 to 75. As has been shown by Weyl, Warren and O'Neill,<sup>35</sup> this relatively low kilovoltage results in better contrast, for as the kilovoltage is increased, the average wave length of the beam is shortened and all tissues are penetrated equally, resulting in less contrast on the exposed film. Removal of the filter aids further in increasing the average wave length of the emergent roentgen-ray beam, with a still greater increase in contrast.

Using the above technique, it is usually possible to visualize the entire uterine wall. A strong source of illumination may be necessary at times to bring this out. The thickness of the uterine wall at term is 1.5 to 2.0 cm. at 36 inch distance. The placenta is noted as a thickening of the uterine wall. In our series of 132 cases, the greatest number were found to be 6 cm. thick with a range of values between 3.5 and 14 cm. when the body of the placenta is located in the fundus and at term. These values are necessarily a function of the tangent of the uterine wall described by the roentgen-ray beam. It has been mentioned by Snow and Rosensohn<sup>26</sup> that the small parts of the fetus almost invariably face the placenta. This has been true in only 79 per cent of our cases; nevertheless, it is of some aid in locating the placenta, but cannot be de-

pended upon in all cases, especially in twins, transverse presentation and hydramnios. When the greatest thickness of the placenta is noted in the superior fundus, it may be safely said that the cause of the patient's bleeding is not placenta previa. When the greatest thickness of the placenta is located on the lateral wall, further study is necessary. Buxton, Hunt and Potter<sup>6</sup> are of the opinion that the lower uterine segment and the internal os may be covered when the mass of the placenta is seen below the equator of the uterus. Only a fair reliability can be credited to this in our series. Of 27 cases found to lie below the equator, 14 were found to be placenta previa or low implantation, while 4 cases noted to be above the equator were known to have a low implantation. A point of greater importance in the examination of the roentgenograms with a possible low implanted placenta is the measurement of the distance between the fetal head and the sacral promontory and between the fetal head and the symphysis pubis. This was first suggested by Brown and Dippel.<sup>4</sup> It requires, of course, a vertex presentation with a normal size fetus and has its maximum value just before the onset of labor, when the head is beginning to engage. In the cases with posterior implantation, but negative for placenta previa, the distance between the sacral promontory and the fetal head averaged 1.7 cm. In those cases proved to be low implanted or marginal placenta previa, the average distance was 3.4 cm. A similar study of the fetal head to symphysis distance with an anterior implantation of the placenta shows that the negative cases averaged 3.0 cm., while those with low implantation and marginal placenta previa averaged 4.9 cm. These values are registered for a 36 inch target-film distance. Consequently, it will be seen that these measurements are of great value in diagnosing a questionable case; this is particularly true for the posterior implanted placenta. It should be a rule that these anatomical landmarks be included in the lateral soft tissue roentgenograms.

In our experience, regardless of the position or presentation of the fetus, it is possible to diagnose the great majority of cases at any time during the last trimester of pregnancy with the two film, soft tissue roentgenographic technique. In any case in which the placenta cannot be visualized in the upper uterine segment, it must be, ipso facto, in the lower uterine segment and is reported as placenta previa. For that group of cases in which the findings are doubtful, a pneumocystographic study is carried out. The value of the use of air in the bladder has been shown by Snow.<sup>27</sup> He found it to be: (1) cheaper than radiopaque media; (2) non-irritating; (3) less dense than the tissues and therefore offering more contrast, as a radiopaque medium will obscure the tissues. The bladder is injected with approximately 200-250 cc. of air. It is important that the bladder be well distended by the air. A partially filled bladder makes interpretation more difficult. At this time, two 11×14 inch films, in the anteroposterior and lateral projection, are taken, centering over the bladder. This is done to prevent distortion of the vesicocephalic measurements. In the cases negative for low implantation or placenta previa, this measurement averages 1.2 cm.; in the positive cases the average measurement is 2 cm. This measurement is best made in the lateral projection. A sign of additional importance is a displacement of the bladder to one side or the other. This occurs when the placenta is implanted on the lateral uterine wall and extends into the lower uterine segment. It is a valuable sign, best seen in the anteroposterior projection. The value of pneumocystography is limited to anterior and lateral implantations of the placenta. A normal appearance may be obtained when the placenta occupies the posterior wall of the uterus and covers the internal os (Jarcho<sup>18</sup>). In these cases a widening of the sacral promontory-fetal head distance should be sought. Another sign of value, associated with this, is a displacement of the fetal head from the mid-coronal and sagittal planes, suggested by Ball and

Golden.<sup>2</sup> This technique calls for films taken in the erect position. As a diagnostic sign, they found it to be extremely accurate. As none of our cases were examined in this manner, we are unable to apply this test to our series.

#### SUMMARY

1. A group of 132 patients with the presenting symptom of bleeding during the last trimester of pregnancy was examined in the Department of Radiology for the presence of placenta previa.

2. The accuracy of this method of examination was 87.8 per cent with the best results in the group diagnosed as negative for placenta previa—97 per cent.

3. The roentgen examination for placenta previa has proved to be a valuable adjunct to the sterile pelvic examination. The two examinations are somewhat complementary. The former enables the obstetrician to treat bleeding cases with greater exactitude.

4. A soft tissue roentgenographic study of the abdomen is first made. If, after careful study, the main portion of the placenta is found to lie in the fundus, it is reported as negative for placenta previa and no further examination is made. If the placenta is not visualized in this position, an air cystogram is done to determine if there is any tissue intervening between the fetal head and the bladder wall.

5. The following signs are of value in positive diagnosis of placenta previa: (a) failure to visualize the placenta in the body of the uterus—suggests central placenta previa; (b) location of mass of placenta below the equator of the uterus; (c) widening of sacral promontory-fetal head distance when the placenta is implanted upon the anterior wall; (d) widening of symphysis pubis-fetal head distance when the placenta is implanted upon the anterior wall; (e) widening of the vesicocephalic distance seen after pneumocystography; (f) lateral displacement of the bladder seen after pneumocystography; (g) displacement of

the fetal head from the mid-coronal and sagittal planes.

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# NON-SECRETING CYSTS OF THE MAXILLARY SINUSES

## WITH SPECIAL REFERENCE TO THE ROENTGEN ASPECTS AND DIAGNOSIS OF THE LARGE TYPES

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THE maxillary sinus is a frequent site for benign cysts of various types. It is the purpose of this paper to discuss the lack of diagnostic clinical signs and symptoms and the importance of the roentgenogram in the diagnosis of the most common type of cyst of the antrum, the so-called non-secreting or mesothelial cyst, with special reference to those which are large and fill the entire antrum.

The recent literature<sup>1,2,3,4</sup> presents interesting studies of benign cysts of the maxillary sinus. A simple classification of these cysts as offered by Lindsay<sup>2</sup> is:

1. Benign cysts arising from the jaw or teeth
  - a. Follicular (dentigerous) cyst
  - b. Radicular (root cyst, dental cyst)
  - c. Median anterior maxillary cyst
2. Benign cysts arising from the sinus mucosa
  - a. Secreting cysts
    - Gland or mucous cysts
    - Mucocele
  - b. Non-secreting cysts of sinus mucosa (Lindsay) (mesothelial cysts of McGregor<sup>4</sup>)

As stated before, non-secreting cysts are by far the most common type of cyst found in the antrum, and only these will be discussed in detail. They arise in the subepithelial connective tissue of the sinus mucosa due to a retention of fluid in the connective tissue spaces. The cause for the retention of fluid is probably the action of bacterial toxins resulting from infection, producing damage of the capillary walls and altering their permeability. The equilibrium of the water balancing mechanisms of the tissues is thus upset.

The rôle of allergy in this process is still in doubt. The increase of fluid in the connective tissue spaces compresses the connective tissue septa, causing them to

break down and thereby allowing individual collections of fluid to coalesce and form cysts. These cysts are not lined by epithelium. On histological examination they appear to have a definite wall. This, however, is formed by connective tissue, and consists of one or more layers of elongated compressed connective tissue cells.

The cysts may vary in size from minute ones, just forming, to those which fill the entire antrum. The length of time it takes for the large cysts to form is unknown. It may vary from months to years. We have observed 3 cases of probable non-secreting cysts, of moderate size (filling approximately one-third of the antrum) with no appreciable change in size over a period of three months.

Even though the cyst wall is very thin the cysts may reach a large size due to the supporting action of the antral walls and floor. It is believed<sup>2</sup> that regardless of their point of origin in the sinus mucosa, the cysts eventually gravitate downward to the most dependent portion of the antrum. When they become large they may prolapse through the ostium of the sinus and then rupture spontaneously. In none of our cases of large cysts did we find any prolapse.

These cysts are said to be found only in the antrum. They are most apt to occur in an edematous soft lining membrane. They contain a thin, clear, amber or straw-colored fluid which coagulates quickly after being removed from the sinus. Lindsay, by chemical analysis, has shown that the fluid in these cysts must be classified as an exudate. The fluid is usually sterile by ordinary culture methods. Occasionally a cyst may become infected, thereby forming a pyocele.

## CLINICAL ASPECTS

*Frequency.* In a series of 80 consecutive roentgen examinations of the sinuses, 13 cases of probable cysts of the antrum were found. Six of these were large non-secreting cysts filling the entire antrum (as far as could be judged by roentgenograms made in the Waters position, without the use of

the examinations were conducted at a time when allergic manifestations are infrequent. All the cases found were in young adult males, twenty-one to twenty-nine years of age.

*Symptoms.* The symptoms of this type of cyst cannot be relied upon for clinical diagnosis. They are too obscure and vari-

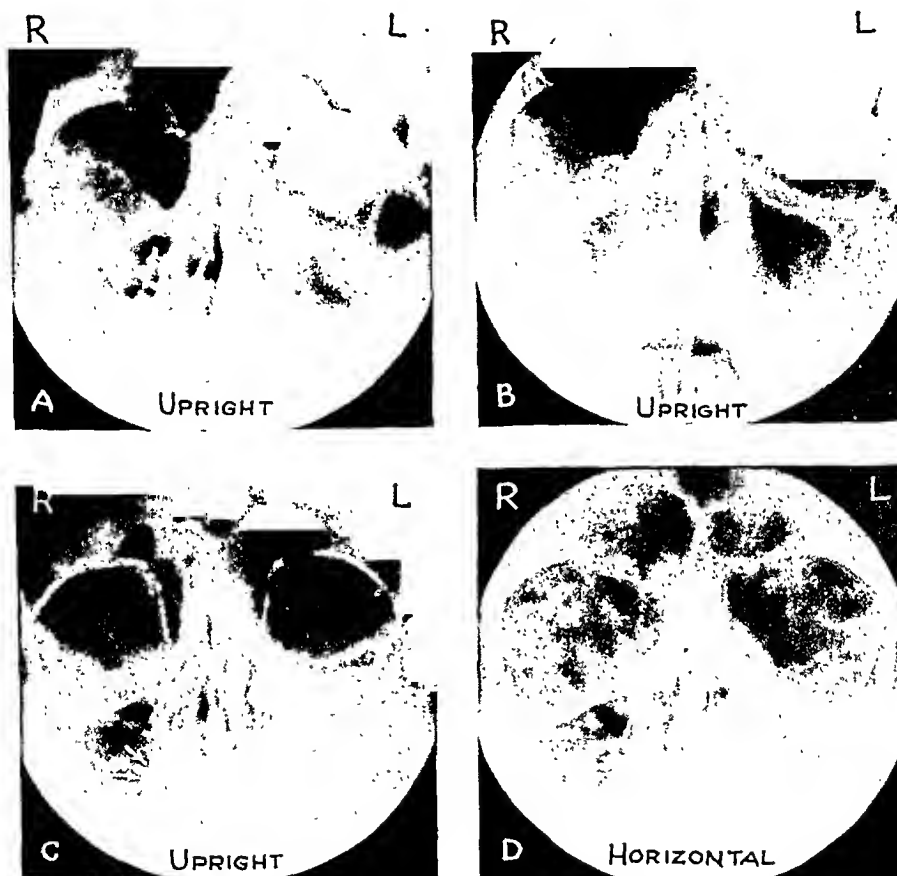


FIG. 1. *A*, typical dome-shaped cyst arising from the floor of the left antrum. *B*, cyst arising from the lateral wall of the right antrum. *C*, large non-secreting cyst filling the left antrum, and a small cyst (arrows) arising from the medial wall of the right antrum. *D*, large non-secreting cyst filling the left antrum.

contrast medium). In 1 case there were large cysts in each antrum. Two of the other cases of large cysts had a small cyst in the opposite antrum. Our series indicates that the bilateral occurrence of these cysts is not unusual.

Cysts were the most common lesion observed in this particular group of cases, although the examinations were made in the winter when acute infections of the sinus are frequent. However, it is also true that

able to set a definite criterion for identification. In our series of 6 cases of large cysts of the antrum the following symptoms were observed: In 3 instances the predominating symptom was *toothache* referred to the upper teeth on the side of the cyst. In 2 cases, a first upper molar was extracted with no relief of the pain. In another case the symptoms of toothache were of such intensity that morphine sulfate was given, with no relief. In this case a tooth extrac-

tion was not done because on examination the teeth were normal. Still another case complained of numbness of the upper teeth. It is probable that in these 4 patients the cysts had completely filled the antrum and were under pressure.

Other symptoms complained of were frequent colds, sore throats, and general malaise. In the 2 cases of large cysts where there were no symptoms referable to the teeth, the patients complained of slight pain in the sinus region, but only after direct questioning. In these cases the cysts were probably not under pressure, although they appeared on the roentgenogram to fill the entire antrum. Lindsay, in discussing the symptoms of his cases of both large and small cysts, believes that these cysts are capable of producing a variety of symptoms, which include . . . "fatigue, irritability, headaches, low grade fever, mild dizziness, pains in the joints. Local symptoms of sinus disease may be present or absent. This type of cyst may constitute a focus in infectious arthritis." McGregor is also of the opinion that these cysts may act as foci of infection. There were no instances of symptoms referable to the teeth in Lindsay's series, although several of the cysts in the cases he reported produced an opacity of the entire antrum.

In none of our cases was there a spontaneous rupture of the cyst with a sudden gush of the typical straw-colored, clear fluid from the nose as does occasionally happen, especially during coughing or sneezing.<sup>2</sup>

*Clinical Examination.* The examination of our patients by nasal speculum was essentially negative. The mucous membrane was of a normal pink color and no pus was noted before or after shrinkage of the membrane. No tenderness to palpation over the involved sinus was elicited, even in those patients with toothache. This is unlike the toothache which may accompany inflammatory disease of the sinus in which there is usually tenderness of the antrum on palpation. The throats appeared normal although 2 patients complained of sore

throat at the time of the examinations. The involved sinuses transilluminated well in all cases. The scarcity or absence of local findings referable to the sinuses is one of the important features of this lesion.

*Results of Antral Puncture in the Large Type of Cyst.* Puncture of the antrum through the inferior meatus produced an immediate spontaneous return of the characteristic cystic fluid when the stylet of the puncture needle was withdrawn. In those cases with intense toothache, there was an immediate cessation of pain after a few cubic centimeters of fluid was allowed to drop out through the needle. The amount of fluid removed varied from 4 to 10 cc. Drainage through the needle stopped spontaneously, probably due to its position. Clotting of the fluid in the needle was minimized by frequently inserting the stylet. None of the cysts was completely drained through the needle, as revealed by post-puncture roentgen studies. In all, the typical straw- or amber-colored, clear fluid was obtained. In all 6 instances the liquid coagulated quickly after removal.

#### ROENTGEN ASPECTS

*Importance of Roentgen Examination.* The roentgenogram is the most important factor in the diagnosis of non-secreting cysts of the antrum, both large and small. This is true because symptoms, signs and findings referable to the sinus may be absent, even in large cysts. Sinuses containing these cysts transilluminate well. This is important since some rely on transillumination. (in conjunction with the clinical findings) for a diagnosis of sinus disease to the exclusion of the roentgen examination. In addition to the above findings, it should be recorded that symptoms of large cysts under pressure may be misleading, since the predominating symptom of pain may be referred to the teeth. Small and even moderate sized cysts may be missed by diagnostic puncture of the antrum. This has been true in our experience and in the experience of others. This is explained on



purely anatomical grounds, the cyst being either too small, or situated in such a position that it cannot be reached. It is here that lipiodol studies may be of value in accurately localizing the cyst so that special techniques of puncture may be used to reach them (Fig. 2). In case of a "dry tap" in instances of cysts missed by puncture, returns of the irrigating fluid may be clear (unless there is infection present in the remainder of the sinus).

Therefore, unless roentgen studies are carried out, an erroneous diagnosis of a normal sinus may be made, due to the absence or scarcity of symptoms and signs of sinus disease, and the possibility of a negative puncture in cases with small and medium sized cysts.

**Technique.** The roentgenogram of most importance in the diagnosis is that made in the Waters position. All sinus roentgenograms are routinely made with the patient in the upright position. If any pathologic appearance is noted on this roentgenogram, a similar view is taken with the patient in the horizontal position. The chief value of this latter view is to show movement of free fluid.

**Findings.** The cysts may arise from any wall, but they are most often seen arising

from the floor of the sinus. Small and moderate sized cysts usually appear as sharply defined, dome-shaped masses projecting



FIG. 2. Lateral view of right antrum following injection of opaque oil (see Fig. 1B for Waters' position of same case). Antral puncture was performed twice without success. The opaque oil injection revealed the anterior location of the cyst (arrows). In such cases a curved trocar and needle are necessary to reach the cyst. This case illustrates that a negative antral puncture and a clear return of irrigating fluid does not rule out antral disease.

jecting into the sinus and are well visualized in contrast to the air in the remainder of the antrum (Fig. 1, A, B and C). These types are easy to recognize roentgeno-

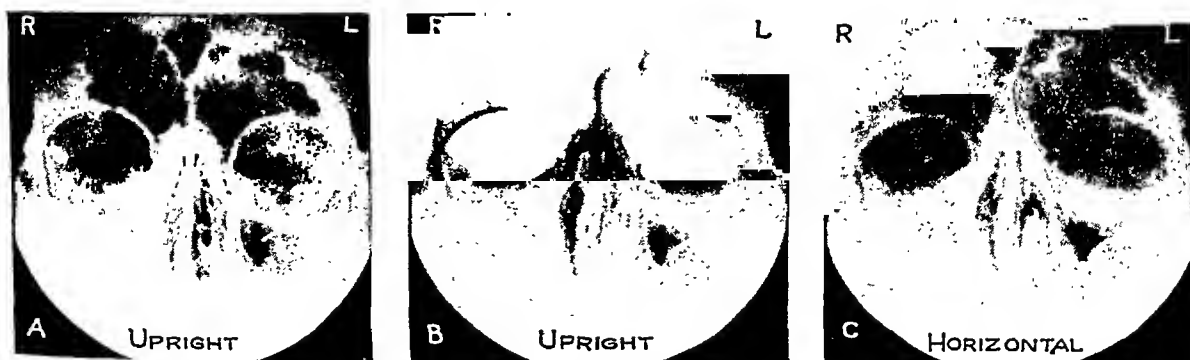


FIG. 3. A, large non-secreting cyst filling the right antrum. Density in the inferior portion of the left antrum with a sharp margin simulating a fluid level. This appearance did not change on a roentgenogram made in the horizontal position, ruling out free fluid. This density represents a small cyst. B and C were made following puncture of the right antrum. The cyst of the right antrum did not change in appearance in spite of the puncture and drainage (spontaneous through the puncture wound) over a two month period of observation. The cyst in the left antrum increased slightly in size. In B its upper margin simulates a fluid line. The roentgenogram made in the horizontal position rules out free fluid and in addition shows a dome-shaped upper border, further substantiating the diagnosis of a cyst.



logically. They are most apt to be confused with solitary polyps. Polyps, however, are apt to occur in individuals with allergic manifestations, and the lining membrane of the sinus in these cases usually shows a generalized thickening. This is not true in sinuses containing cysts, although occasionally one portion of the lining membrane may appear thickened, due probably to an accumulation of cystic fluid which has not united with the main cyst.

Occasionally a cyst in the floor of the

sinus. This finding is mentioned by McGregor, Lindsay, and Hardy. Judging from their experience and from ours, these cysts are a common cause of an opaque sinus on the roentgenogram (Fig. 1, *C* and *D*, Fig. 3, 4 and 5). The following are the characteristic roentgen findings produced by these large cysts:

1. *An increase in density of the entire antrum.* The density is usually uniform. In the Waters position, ethmoid cells are frequently seen in the superior and medial

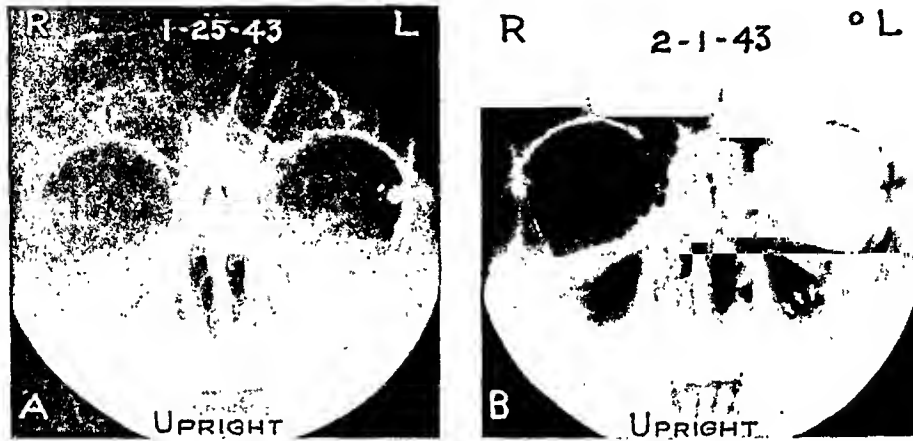


FIG. 4. *A*, large non-secreting cyst filling the left antrum. Hyperplastic sinusitis of the right antrum. *B*, roentgenogram made following puncture showing the collapsed cyst in the inferior portion of the antrum (arrows). A roentgenogram made March 3, 1943, showed a normal sinus.

antrum may simulate a fluid level when the roentgenogram is made in the upright position. This is not uncommon since we have observed 2 such cases. Pancoast, Pendergrass and Schaeffer<sup>5</sup> illustrate a similar case. Two of Lindsay's cases presented this appearance, one being reported as a fluid level, and the other being reported as resembling a fluid line. One of Hardy's<sup>1</sup> cases was similar in appearance. It is here that the roentgenogram made in the horizontal position is of greatest value. Free fluid would change its position and cause a clouding of the entire sinus. Fluid in a cyst remains localized and may, due to pressure changes and slight changes in angle of exposure, become characteristically dome shaped (Fig. 3).

As the cysts grow, they become large enough to produce an opacity of the entire

aspect of the antrum. These may either be ethmomaxillary cells or posterior ethmoid cells or both. In addition, a part of the superior orbital fissure and the infra-orbital foramen may be projected into the superior portion of the antrum. These cells, the fissure and the foramen, due to their radiolucent appearance, produce some irregularity in the superior and medial portion of the density produced by the cyst. Here it would be well to mention that it is also possible for membranous or osseous septa to form separate compartments in the sinus, so that a cyst could fill one compartment only. We have not encountered such a case.

2. *No change in the appearance of the density in upright and horizontal views.* This is important in those instances where roentgenograms are routinely taken in the horizontal position. It is essential that roent-

genograms be taken in the upright position to rule out free fluid in the sinus (Fig. 6).

3. *No change in osseous wall of the sinus to indicate either infection, pressure atrophy, or bone destruction due to invasion.* This is explained by the lack of active inflammation (the fluid is usually sterile by ordinary culture methods), the benign character of

sent, and that the sinuses transilluminate well, enables one to make the diagnosis. At some time in the development of these cysts there must be a stage between the typical dome-shaped cyst and the large cyst filling the entire sinus, in which the cyst will fill most of, but not all of the antrum. We have not encountered such a case. However, in the

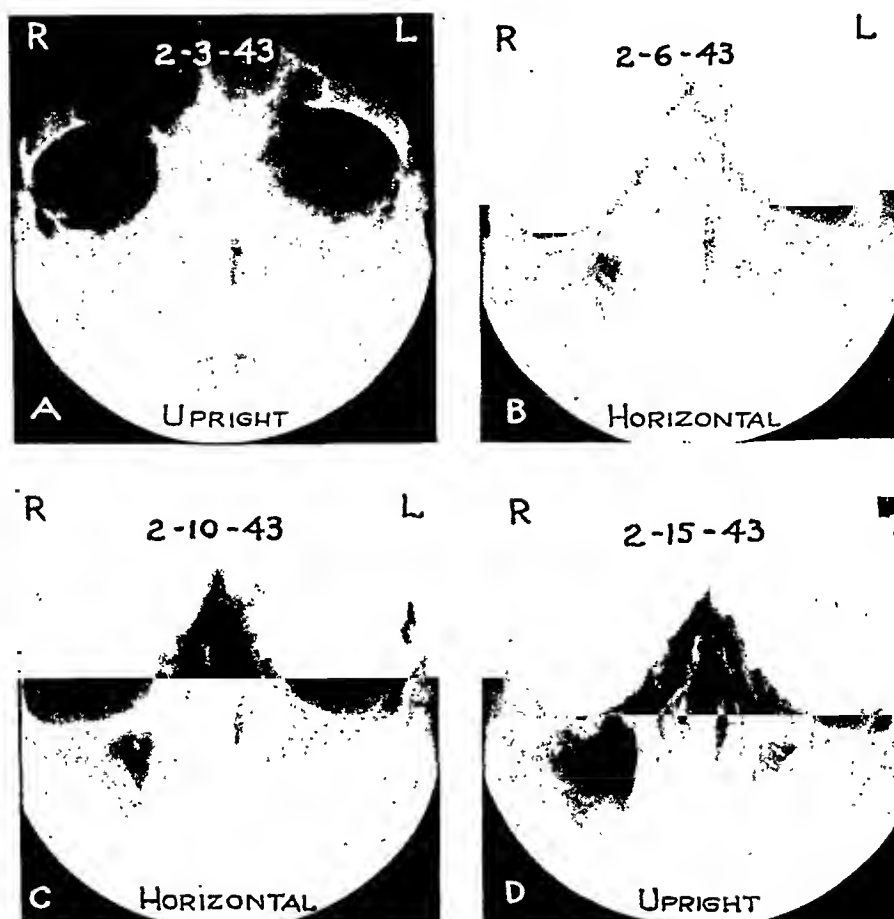


FIG. 5. *A*, large non-secreting cysts of both antra. Each antrum was punctured. The cyst on the right side collapsed rapidly in the twelve days following the puncture during which time cyst fluid drained through nose. *B*, *C*, and *D*. Note the resemblance of the partially collapsed cyst (*B*) to a thickening of the lining membrane of the sinus. Although cyst fluid drained from the left side during this period the cyst did not collapse readily. In *D* collapse has occurred to a sufficient degree so that the top of the cyst is visible (arrows).

the cysts, and their structure, that is, their thin lining and their tendency to prolapse through the ostium when they become large, and to rupture spontaneously rather than to produce pressure atrophy.

It is possible from these roentgen findings alone to suspect the presence of these cysts. The knowledge that local signs and symptoms of sinus disease are few or ab-

presence of an opacity of the major part of the antrum, which does not alter its shape in upright and horizontal views, and in which the sinus wall shows no changes, a cyst should be considered. Furthermore, if the clinical signs and symptoms of sinus disease are few or absent, and the sinus transilluminates well, the diagnosis of a cyst is justified.

*Roentgen Studies Following Puncture of Large Cysts.* In 1 case, one week following the puncture, during which time cystic fluid drained through the nose, the cyst was collapsed and appeared as a small nodule in the floor of the sinus, with the typical dome-shaped appearance of small cysts. Four weeks later the antrum appeared normal (Fig. 4).

In another case, following puncture cystic fluid drained in small amounts through the nose, but the cyst did not col-

roentgen appearance. These include:

1. Inflammatory lesions
2. Cysts of dental origin
3. Mucous cysts and mucocoeles
4. Polypi
5. Tumors (especially carcinoma) and granulomata.

In all of these conditions, the sinus transilluminates poorly. In brief, the following are the most important additional points in the differential diagnosis:

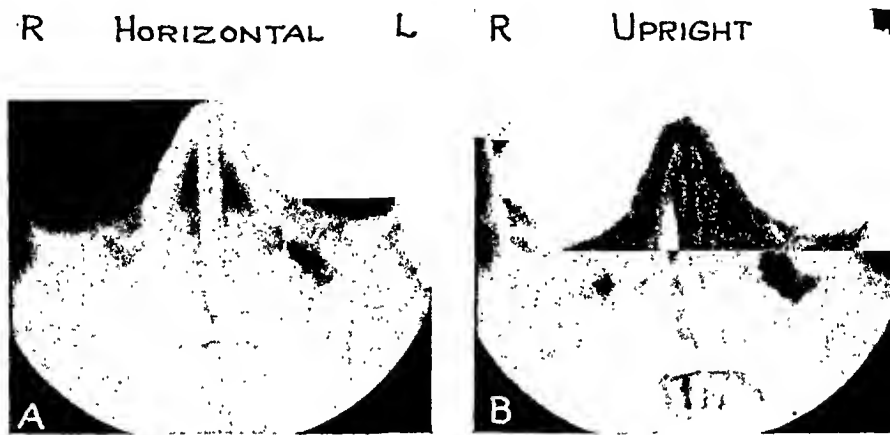


FIG. 6. *A*, roentgenogram made in the horizontal position shows a diffuse opacity of the right antrum. In this respect a cyst is simulated. However the roentgenogram made with the patient in the upright position, *B*, shows a fluid level, with a thickened lining membrane. This was an inflammatory lesion, with clinical signs and symptoms of acute sinusitis. The sinus did not transilluminate.

lapse, and its appearance on the roentgenogram remained unchanged (Fig. 3).

In the patient with the bilateral cysts, puncture was performed on both sides, Drainage through the nose followed thereafter. On one side the cyst collapsed rapidly. At one stage in this process of regression, the findings on the roentgenogram simulated a thickening of the mucoperiosteal lining of the sinus. The cyst on the other side collapsed very slowly. This was only evident roentgenologically after the cyst on the opposite side was almost completely collapsed (Fig. 5).

*Differential Diagnosis.* The large, non-secreting cyst which produces an opacity of the entire antrum must be differentiated from all other lesions producing a similar

1. In acute inflammatory disease of the antrum the opacity seen in the roentgenogram is due to the thickening of the lining membrane of the sinus, or fluid, or both. Roentgenologically, fluid may be demonstrable by roentgenograms made in different positions. These also show the thickening of the mucoperiosteal lining of the sinus, either alone or in combination with fluid. The hyperplasia of the membrane may not be visible on the horizontal view when there is fluid present. The upright view which results in a shift of the fluid to the most dependent portion of the sinus will reveal this thickened membrane (Fig. 6). The clinical signs and symptoms of acute sinus disease are quite apparent. The hazy appearance of the sinus wall, seen in

acute inflammatory processes of the antrum, may also be detected (Fig. 7). Inflammatory lesions are the ones which have to be differentiated most often.

2. In cysts of dental origin, the relationship to the teeth should be demonstrable by careful roentgen studies, and changes in the floor of the sinus may be detected.

3. Mucocoeles are rare in the antrum. We have never observed one, but in mucocoeles large enough to produce an opacity of the antrum, pressure or invasion changes are

#### SUMMARY AND CONCLUSIONS

1. In a consecutive series of eighty roentgenograms of the sinuses for a suspected pathologic condition, thirteen instances of probable cysts of the antrum were found. Six of these produced an opacity of the entire antrum. These were found to be non-secreting or mesothelial cysts. In our experience, non-secreting cysts are the most common type of cyst occurring in the antrum.

2. Local signs and symptoms of sinus dis-

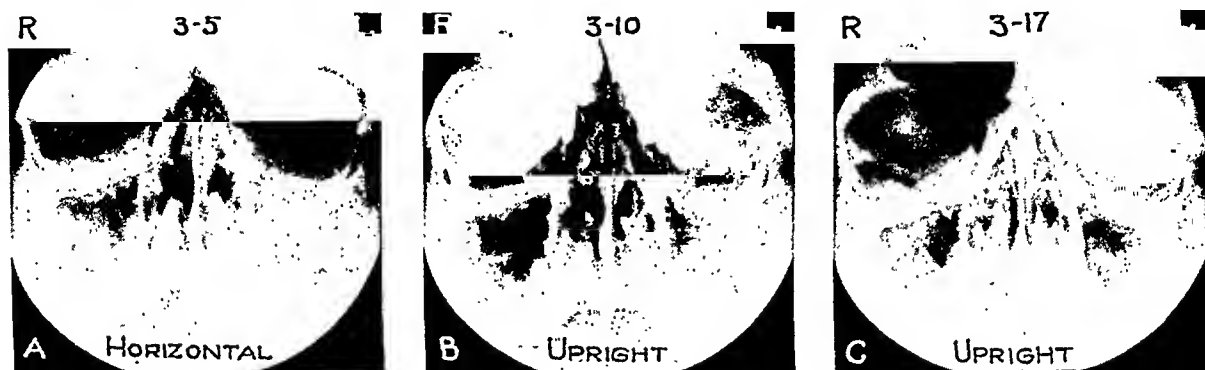


FIG. 7. *A*, opacity of the left antrum with no change in its appearance in the upright and horizontal position. (Only the horizontal view is shown.) In this respect a cyst is simulated. However, the sinus wall shows the hazy appearance of an acute infection, and clinically the signs and symptoms of an acute sinusitis were present. The sinus did not transilluminate. The opacity in this instance was due to an acute inflammatory lesion with thickened membrane and pus. Local treatment resulted in rapid improvement. *B* and *C*. In *B*, the appearance is due to an irregularly thickened membrane. Note the inequality of size of the maxillary sinuses an anomaly of development.

usually present in the wall of the sinus. At this stage, too, they are apt to produce external deformity of the face, and marked pain in the sinus.

4. Carcinoma of the antrum, which is the most common malignant tumor encountered, is apt to have caused bone destruction, invasion of adjacent soft tissue, and may produce severe pain by the time the roentgenogram shows a diffuse opacity of the antrum.

5. Polypi are most apt to occur in individuals with allergic manifestations. In those instances where the entire antrum is opaque due to polyps, there are apt to be polypi in the nose, easily detected by nasal examination.

ease may be absent or meager even in large cysts of this type. The sinuses transilluminate well. Small and medium sized cysts may be entirely missed by antral puncture. Antral irrigation in such instances is usually also negative. Therefore the roentgenogram is the only way to detect their presence.

3. Large cysts under pressure may give rise to severe toothache as the predominant symptom. In these instances there is no tenderness over the involved antrum, such as is often present in inflammatory lesions of the sinus giving rise to toothache.

4. When the cysts become large they produce an opacity of the entire antrum on the roentgenogram. This opacity remains

constant in appearance on roentgenograms made in the horizontal and upright positions. There are no changes in the sinus wall to indicate either infection, pressure atrophy, or invasion.

5. In the presence of an opaque antrum, with the characteristics given, a large non-secreting cyst should be considered. Knowing the clinical findings and with the knowledge that the sinus transilluminates well, the diagnosis can be made with reasonable certainty.

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# POSTOPERATIVE EMPHYSEMATOUS BULLAE FOLLOWING LUNG ABCESS\*

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**P**ATHOLOGICAL conditions following surgical treatment of lung abscess have not been the subject of much roentgenographic investigation. Farrell<sup>2</sup> made a rather comprehensive study of postoperative changes in 23 cases of lung abscess, describing the appearance of ribs, pleura, lung and diaphragm. He found the usual uncomplicated course, roentgenographically, was peripheral clearing of the dense shadowing in the lung terminating in either a clear lung or more or less fibrosis, depending on the site and size of the abscess and the amount of surrounding pulmonary involvement. No mention is made of the finding of emphysematous bullae or pneumatocele. Boch<sup>1</sup> reported a case of emphysema and bronchiectasis in which there had been a history of the patient recovering from a lung abscess. At autopsy, there was a cavity whose trabeculated walls contained connective tissue. The interior space was lined with smooth, glistening membrane of epithelium similar to that in a bronchiole. It is not clear from the information given whether this was a pneumatocele or an epithelized, residual lung abscess. Franklin<sup>4</sup> described 6 cases studied by means of bronchography, illustrating various types of residual defects in the lung and bronchi, classifying them as cavitary and bronchiectatic. In the case here reported, another type of defect following surgical treatment is described.

## CASE REPORT

A. S., Mexican female, aged fifteen. Present illness dates from October, 1938, when tonsillectomy was performed under a general anesthetic. Several days later, the patient became ill with severe cough and expectoration of foul, purulent sputum. The temperature was 103° F. In December, 1938, she had a hemopty-

sis and was sent to the Los Angeles General Hospital. The sputum was reported as positive for acid-fast bacilli and she was referred to the Olive View Sanatorium with a diagnosis of moderately advanced pulmonary tuberculosis (Fig. 1). The temperature range at this time was 99.6 to 100.0° F., pulse 80 to 130, respiration 20 to 26, sputum 2 to 6 ounces daily, puru-



FIG. 1. Dense, confluent involvement in middle part of right lung with fluid level.

lent and with a very foul odor. On two different occasions in January, 1939, acid-fast bacilli were found on concentration. Unfortunately, there were no cultures or guinea pig inoculations. Bronchoscopy, on January 24, 1939, showed pus welling from the right upper lobe bronchus. The roentgen examination at this time (Fig. 2 and 3) showed an increase in dense, confluent involvement through most of the right lung with several fluid levels due to cavity or abscess formation.

Despite the finding of acid-fast bacilli in the sputum, it was considered that the patient had a lung abscess and operation was performed on

\* Presented before the Trudeau Society of Los Angeles in May, 1943.



FIG. 2. Marked increase in involvement with multiple fluid levels, eleven days after first roentgenogram.

February 1, 1939, with resection of portions of the third and fourth ribs anteriorly. Three



FIG. 3. Lateral view showing location of abscesses in right lung.

abscesses were opened with cautery and drained. Both the pus evacuated from the abscess and a section of the abscess wall were negative for tuberculosis, both by culture and guinea pig inoculation. The pus showed many gram-negative pleomorphic motile bacilli.

The postoperative course was uneventful; cough lessened immediately and expectoration dwindled steadily, ceasing in six weeks. Clinical improvement continued until her discharge, in December, 1939, at which time she was free from all symptoms and in a better state of nu-

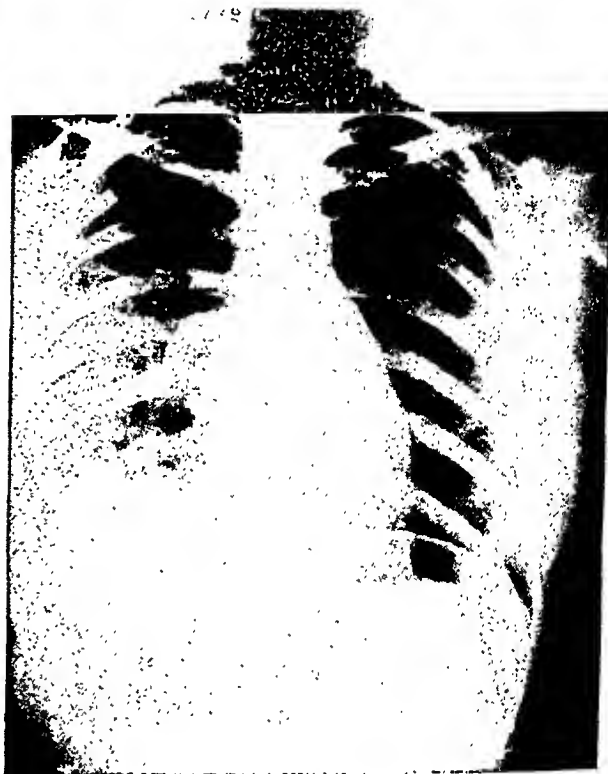


FIG. 4. Conventional roentgenogram nine and a half months after drainage of abscesses. There is slight thickened pleura over the right lung with a few clear-cut linear shadows.

trition than she had ever previously experienced.

A conventional roentgenogram in November, 1939 (Fig. 4) showed considerable thickened pleura over the site of operation and a number of very fine, thin, interlacing, white lines through the region where the abscesses had been located. Because the nature of these shadows could not be determined adequately in the stereoscopic view, the patient was examined by means of the rectilinear planigraph. The planigrams of the anterior half of the right lung (Fig. 5) showed several high-lighted areas, near the

lateral chest wall, bounded by very thin, almost hair-like white lines, with no lung markings within them. These were rather irregular in shape and of variable size. Lateral planigrams (Fig. 6) through this region showed them even more distinctly and in this projection they were more rounded.

#### COMMENT

This case was something of a diagnostic problem because of the finding of acid-fast bacilli in the sputum on three different occasions in two different institutions. However, in retrospect, it hardly seems possible that the abscess cavities present in the lung were due to tuberculosis, because of the very prompt result of open drainage which is not the experience encountered in treating tuberculous cavities by this method. Since no cultures or animal inoculations were made preoperatively and the pus evacuated at operation was negative by



FIG. 6. Lateral planigram of same area, showing emphysematous bullae.

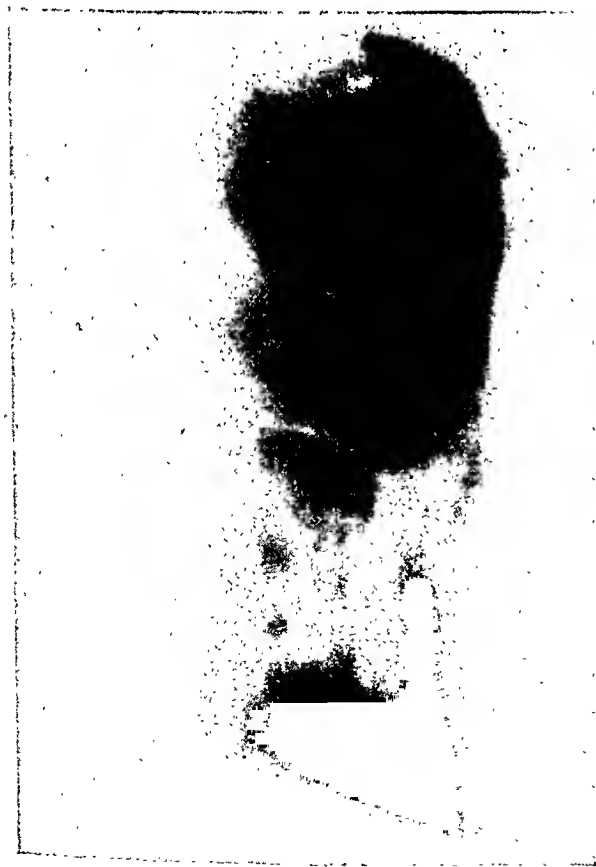


FIG. 5. Planigram of right lung showing several emphysematous bullae at former site of lung abscess.

culture and guinea pig inoculation, it must be concluded that the acid-fast bacilli were some non-pathogenic organism rather than tubercle bacilli.

The shadows observed in the planigrams are not of the type characteristic of tuberculous cavities, bronchiectatic dilatations or residual abscesses. The outlining walls are very thin, uniform in thickness and there is no increase in density of the surrounding parenchymal structure. The appearance is the same as in patients with emphysematous bullae, as described by Freedman,<sup>5</sup> Hayashi,<sup>6</sup> Jäderholm,<sup>7</sup> Laurell,<sup>8</sup> and others. Peirce and Dirkse<sup>9</sup> described 4 cases in which pneumonia was followed by the development of what they termed "pulmonary pneumatocele (localized alveolar or lobular ectasia)." The appearance of these lesions is essentially the same as in the case described above except for size and number. They feel, as does Fischer-Wasels,<sup>3</sup> that inflammatory changes result in a



check-valve mechanism with the production of progressive distal expansion of distal alveoli. Hayashi found evidence of a valve-like structure at the base of such vesicles. In this case, there was surgical interference in this immediate area and the formation of bullae could presumably result from either process or both.

If seen for the first time, without the history which this case presented, these bullae might fall into a considerable class of cases probably very largely misdiagnosed congenital cystic disease. The first roentgenograms made on this patient showed nothing even suggestive of pneumatocele.

As Peirce and Dirkse have shown, pneumatoceles may completely disappear and even if they do not, there seems to be no unfavorable clinical prognosis. Routine investigation of cases of healed lung abscess by body section roentgenography, especially among those who have received surgical treatment, would probably yield similar findings in a certain percentage of cases, with entire absence of symptoms. It is important, however, to realize the possibility

of such changes, to avoid confusion with residual infective pulmonary defects.

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# DIFFICULTIES IN THE ROENTGENOLOGICAL EXAMINATION OF THE BILIARY TRACT

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THE value of cholangiography in the diagnosis of lithiasis of the main bile duct is unquestioned. This was really the object pursued when it was first performed, and is the motive of its continued employment.

At present, however, there is the tendency to use this exploratory procedure as a method to ascertain the physiology and pathological disturbances of the biliary tract, often ignoring useful knowledge obtainable from other procedures.

For this purpose, cholangiography is undoubtedly of great help and sometimes affords useful lessons, but it can also lead to error if incorrectly interpreted.

If it is sometimes difficult to determine the existence of an intracanalicular concretion, it is naturally much more so to ascertain the functional activity or discover a disorder.

Often spasms of the ducts are diagnosed, because at a certain level their shadow is obliterated or narrowed.

Peristalsis of the bile ducts is described, simply because their borders are irregular or wavy.

Dystonia of the sphincter of Oddi is mentioned, because Wirsung's duct is visualized.

Syndromes of biliary dyskinesia are spoken of, by the sole observation of one or two cholangiograms taken with short intervals.

Summing up, it is sometimes thought that cholangiography is an infallible image of all that occurs in the biliary tract, forgetting that a roentgenogram is only a stationary record incapable of showing details of the dynamics of the ducts; and that, while it is true that it can give information as to the presence or absence of stones, the permeability of the ducts or their abnormal-

ities, it does not permit us to judge of their functional activity.

Those who have performed a few cholangiographies will agree that the roentgenology of the bile tract involves serious problems. Often they have been perplexed by a shadow which may or may not be that of a stone. They have been surprised when, during a second operation, one or more concretions were found which were not demonstrated on the roentgenograms.

They want to know why the opaque medium does not penetrate the terminal portion, or why the ducts show an unusual image.

In a word, cholangiography is not always entirely satisfactory, and although prolonged study of the case sometimes throws light on the matter, by changing the quality or quantity of the contrast medium, repeating the examination and modifying the position of the patient, it is also true that at times our efforts are useless.

With the purpose of pointing out the difficulties which the interpretation of these cholangiograms present, we will study the uncertainties and errors of diagnosis in lithiasis of the choledochus, and the chapter of biliary physiopathology, as shown by cholangiography.

## CHOLANGIOGRAPHY AND LITHIASIS OF THE PRINCIPAL BILE DUCT

Calculi of the bile ducts can be diagnosed by cholangiography, either because they show up directly, or because they alter the shadow of the ducts indirectly.

(1) *Direct images are those which appear at the site occupied by the stone itself, and are of two varieties:*

(a) The lacunar image, which appears when the contrast medium envelops the foreign body completely, making it stand



FIG. 1. Postmortem cholangiogram. Injection of 6 cc. of lipiodol through the cystic duct. Previously four calculi about the size of shot were placed in the bile duct. Of these only one is distinguishable by the inverted dome-shaped image seen in the upper part of the hepatic duct.

out as a transparent area in the midst of the opaque shadow. To obtain this image the stone must be in contact with the duct wall, thus preventing the medium surrounding it completely; if this should happen, the layer of medium would be thin enough not to conceal the stone.

When this layer interposed between the wall and the calculus is not thick enough to hide the concretion, it may, however, diminish its intensity, thus giving less definite images, with diffuse borders, or only slightly less opacity than the rest of the tract. In these cases interpretation becomes very difficult.

(b) When the contrast medium has not entirely enveloped the periphery of the foreign body, but only a part of its contour, dome-shaped, angular or semilacunar (border-lacunar) areas are obtained, according

to the position, shape and size of the concretion.

The dome-shaped image is described as characteristic of calculi which obstruct the final portion of the choledochus, and for it to appear the concretion must be ovoid, and the contrast medium only come in contact with its upper border, or only allow a very slight passage of the injected substance. The various images depend on the shape and on the quantity of medium which manages to find its way past the stone.

The inverted dome-shaped image appears when the concretion is in the hepatic duct or one of its branches, impeding the upward passage of the medium, and which is only in contact with its lower border (Fig. 1).



FIG. 2. Same as Figure 1. Immediately afterwards a second injection of 4 cc. of lipiodol was given and a roentgenogram made. Only two stones are now visible in the hepatic duct. On opening the biliary tract the other two stones were found; one in the middle part of the choledochus, the other lodged in the ampulla of Vater.

It should be stated that sometimes calculi in the terminal part of the choledochus may present a right-angled border, or one with a slight convexity downwards, simulating a normal contraction of the sphincter of Oddi, or a complete obliteration due to extrinsic compression.

The dome-shaped image is not always due to a stone in the terminal portion; there are cases, as we shall see, in which it appears in spite of there being no obstruction. When this occurs, either in the first or following cholangiograms a normal passage of the medium into the duodenum can be seen, which is not so when it is due to a foreign body.

Finally, it must not be forgotten that a small stone, loosely lodged in the ampulla of Vater, may pass unnoticed; in this case, the stasis and reflux in Wirsung's duct may draw attention to it (Fig. 2).



FIG. 3. Postoperative cholangiography; 10 cc. of 25 per cent yodolipol. The contrast medium has filled the choledochus, the hepatic duct and its left branch; the right branch is not visible.



FIG. 4. H. C., May 7, 1942. Postoperative cholangiogram; 20 cc. of 25 per cent yodolipol. With a greater amount of contrast medium a semilacunar or border lacunar image may be seen at the division of the hepatic duct. It is due to a calculus which obstructs the right branch of this duct, impeding its filling.

The lacunar image on only one side of the duct (semilacunar or border-lacunar) occurs when the stone allows the medium to pass on only one wall of the duct, leaving a dent or wave on the opposite border.

(2) *Indirect images are those that indicate the existence of calculi, by the alterations they make on the shape of the ducts.* These may be:

(a) Dilatation of the biliary tree, a morphological alteration less related to the concretion itself than to the hypertrophy of the sphincter of Oddi.

(b) Reflux in the intrahepatic biliary system, which is not of great importance, as it may be related to any obstruction in the lower part of the choledochus, and to the quantity and pressure used in the injection of the contrast medium.



FIG. 5. Postmortem cholangiogram; 5 cc. of 25 per cent yodolipol. Previously two stones the size of shot were placed in the biliary tract; their images can be seen in the middle portion of the choledochus. Below them, several round shadows can be seen which are due to air bubbles.

(c) The failure of passage of the medium into the duodenum; also of only slight value either because of many reasons which may be responsible, or because one or several concretions are sometimes sufficient to prevent its transit into the bowel.

(d) Finally, let us mention the impossibility or difficulty of filling of one or both branches of the hepatic duct, which occurs when a stone is situated at that level and is not visible directly (Fig. 3 and 4).

The uncertainties and errors which render difficult the visualization of an intracanalicular concretion appear either because an image is badly interpreted, or because the roentgen ray itself makes the visualization difficult.

We will call the former errors of interpretation, and the latter errors of omission.

1. The errors of interpretation are due to technical defects, abnormalities of the biliary tract, edema caused by cholecystitis, superimposed duodenal shadow, deformities caused by vertebrae, or any cause which hinders the correct appreciation of the image obtained.

Injection of air bubbles in the biliary tract can bring about false images; these are usually round or oval in shape, with regular edges, and show up more intensely than the calculous image, as negative areas, apart from being fugitive and displaceable, either spontaneously or by injecting more opaque substance (Fig. 5 and 6).

Bile tract abnormalities, or the space be-



FIG. 6. Postmortem cholangiogram; 8 cc. of 25 per cent yodolipol. Three more cubic centimeters of opaque medium were injected immediately afterwards and the second cholangiogram was then taken. Note how the calculous images have varied their position. In the lower part of the choledochus the air bubbles have fused into one large one. The opaque medium shows the outline of the ampulla of Vater, allowing of its visualization.

tween the branches of the hepatic duct, may cause error. Desplas, Moulouguet and Malgras mention the case of the cystic duct opening into the hepatic duct on its anterior aspect. We have a case in which the branches of the hepatic duct, outlining a negative image, might have been erroneously interpreted as a stone. In this case another roentgenogram, taken from a different angle, eliminated all doubt.

Choledochitic edema is mentioned by Desplas, Moulouguet and Malgras as the most important cause of an abnormal image. These authors mention as a means of differentiating these shadows from the truly calculous ones the fact that they are found in the middle of the dilatation and not at the end of the dilated segment, and also the variability in shape and position with which they appear in repeated roentgenograms.



FIG. 7. H. C. 12413, May 8, 1942. Postoperative cholangiogram; 25 cc. of 40 per cent abrodil. The excess of contrast medium conceals two stones in the hepatic duct.



FIG. 8. H. C. 12413, May 8, 1942. Postoperative cholangiography; 25 cc. of 40 per cent abrodil. After thirty minutes most of the opaque medium has been eliminated; the images of two calculi may now be seen.

We believe the first sign to be of little value, as one or more stones lodged in the duct can produce lacunar images in the middle of the dilatation; on the other hand, we find the second sign of greater value, since the calculous shadow is generally permanent and does not vary; we say generally, because on some occasions we have found mobility and variations in the shape of its image (Fig. 8).

The superimposition of the duodenal image may not only conceal the terminal portion of the biliary duct and hide a concretion therein, but may sometimes resemble one, especially when one of the shadows made by the intestinal mucosa simulates a dome-shaped image placed exactly on the last portion of the choledochus.

Should this be the case, the passage of the

opaque medium into the intestine is an index of the absence of any obstruction in the last portion of the duct; this could be confirmed by another roentgenogram taken shortly afterwards.

The deformity produced by pressure of the vertebrae can give lacunar images by contact between the duct walls, when the ducts are displaced medially. These false images disappear or are modified either spontaneously or by increasing the quantity injected.

2. Errors of omission are those incurred when the roentgen ray does not permit the visualization of an intracanalicular concretion, and they originate either in the quality or quantity of medium used, or in the relation between the size of the calculus and the capacity of the biliary tract.

The following render visualization difficult: (a) poor distribution, scarcity or excess of the injected medium; (b) use of very opaque preparations; (c) small calculi lodged in dilated ducts.

Scarcity, defective distribution, and rapid passage of the medium into the duodenum do not need further explanation as causes which make visualization of a foreign body difficult. Nothing can assure us that, in a region where the opaque substance has not reached, there are not one or more calculi which have been overlooked.

Regarding the excess of medium, it may lead to the same result, dilating the biliary tract and allowing the passage of the medium between it and the stone, thus making the shadow of a stone less defined or invisible. Naturally, for this to occur, the stone must be loose in the duct, therefore one must wait for the choledochus to empty partially; then the negative image will appear as soon as the stone has come in contact with the duct wall (Fig. 7 and 8).

Excessive opacity of the contrast medium has been mentioned frequently, so we will not emphasize this difficulty; let us say only, that however thin the layer of fluid lying between the stone and the duct walls, it may be sufficient to conceal the former.

Finally, let us point out that the visualization of a calculus depends on its relative size compared to the caliber of the duct. Any small stone, lodged in a dilated tube, can be surrounded by the medium, and be easily overlooked (Fig. 7).

#### CHOLANGIOGRAPHY AS A METHOD OF STUDYING BILIARY PHYSIOPATHOLOGY

The utility of cholangiography as an auxiliary method to explain certain problems of physiopathology is a matter of importance. But when it is attempted to explain certain functions, or new functional syndromes are created based only on one or two roentgen studies and without considering the knowledge afforded by other methods of investigation, we believe that it is demanding too much of cholangiography.

Not only are spasms of the sphincter of Oddi mentioned as a cause of biliary stasis, but it is claimed insistently that spasms of other parts of the duct cause fleeting jaundice and biliary colics.

Roentgenologically, the activity of the two portions of the sphincter—vagotropic and sympathicotropic—are separate, and the latter's dysfunction is spoken of because Wirsung's canal is visualized when the functional value of the sphincter of the ampulla of Vater is still being discussed.

While histology denies to the principal bile path any peristaltic activity, roentgenologically it is spoken of frequently. As may be seen, roentgenological interpretation is not in accordance with facts in the face of other procedures.

In the light of that knowledge, we will study the images which appear in the terminal portion of pathological biliary ducts, and refer finally to the motility of the main biliary tract.

The intestinal portion of the biliary and pancreatic ducts is surrounded by a muscular system described in 1877 as the muscle of Oddi. In view of the relation it has with the muscular coat of the duodenum, the functional value of this sphincter has



been, and still is, discussed. Even today, there is a tendency to accept that it is capable of active function apart from the intestinal musculature.

Three parts are studied in this muscular formation: (1) the muscle of the ampulla of Vater, or sphincter of the papilla; (2) the muscle of the choledochus, or sphincter of the choledochus; (3) the muscle of Wirsung's duct, or pancreatic sphincter.

The first is a frail annular muscle which circumscribes the ampulla of Vater, a segment of the biliary tract which has suffered an involutionary process, being in the adult an insignificant portion if compared with the intestinal part of the choledochus (Fig. 9).

The second is the most important part of the sphincter of Oddi, and is a strong muscular sheath which extends from the junction of the choledochus and Wirsung's



FIG. 10. Transverse section of the terminal part of the biliary and pancreatic ducts, 8 mm. above their junction.  $\times 17$ . Masson's trichromic stain. The choledochus is surrounded by a strong muscular ring capable of halting the flow of bile when contracted. The muscular fibers which belong to Wirsung's duct surround only its posterior semi-circumference; therefore to call it a sphincter is incorrect. This observation corresponds to a case of lithiasis of the hepatocholedochus.



FIG. 9. Transverse section of the ampulla of Vater in its middle portion.  $\times 17$ . Masson's trichromic stain. The ampulla is surrounded by a few muscular fibers whose importance as elements capable of stopping the bile column by their contraction must be entirely discarded. This observation is of a gall-bladder obstructed by a calculus lodged in the cystic duct.

duct to above the intestinal foramen, varying in length from 8 to 15 mm. in normal cases, acquiring more length and development in pathological conditions (Fig. 10).

The third is the least important muscular group, and in most adults Wirsung's duct has no sphincter of its own in the sense of an intrinsic ring of muscular fibers that surround the canal entirely, for those that exist only cover its posterior semi-circumference, and do not deserve the name of sphincter (Fig. 10).

From a functional point of view, the sphincter of the papilla is not capable of offering much resistance to the passage of bile or pancreatic juice, as being a weak muscular ring and the ampulla being a very



short segment (2 mm. in length in 45 per cent of adults, according to Giordano and Mann) it is not conceivable that its contraction could detain the bile column and maintain an increased pressure in the hepatocholedochus.

In this sense we agree with Schwegler and Boyden, who not only doubt that the sphincter of the papilla can offer any appreciable resistance to the biliary and pancreatic flow, but they do not think it probable that it can participate in biliary dyskinesia.

Roentgenologically, on the contrary, it is supposed to play an active part in the production of these conditions; the visualization of Wirsung's duct is given as a sign which reveals this disorder.

It is logical that reflux of the medium into this canal, when it empties into a common ampulla with the choledochus, is only possible when at that level there is a cause which obliges the content of one duct to pass into the other. This cause may be a calculus, an excess of contrast medium or excessive pressure while injected.

These, however, are not the cases under discussion; they are those in which the filling of Wirsung's duct does not answer to any of these causes. It is in these cases that we must investigate whether the sphincter of the ampulla plays any part.

Mirizzi believes that it does, and states that visualization of the pancreatic canal is the expression of a dysfunction of this muscular ring, which he calls dystonia.

This author bases his hypothesis on the following reasons: (1) observation of two phases—complete closure of the papilla and partial opening which permits the injection of the duct; (2) progressive regurgitation of the opaque substance in the canal; (3) modification of the shape of the duct, which appears as a sinuous and dilated tract.

The first is commonly observed, but we differ in its interpretation, accepting, as opposed to Westphal's opinion, that it is not the closure of the sphincter of the papilla that causes the opaque column to halt but the contraction of the sphincter of

the choledochus, which with its considerable development and strategic situation is the most indicated to detain the biliary column. Schwegler and Boyden, whose studies in histology and biliary physiology are well known, accept this hypothesis and say that it is this muscle which has the function of closing the bile duct, thus detaining the column of bile, without participation of the intestinal muscle. As an argument in their favor they quote Ivy, Voetlin and Greengard's experiment in man, which proves that the bile column can be detained in spite of an abundant flow of pancreatic fluid; this would not occur if it were the sphincter of the papilla that controlled the flow of bile.

The progressive reflux of the contrast medium into the canal, if it does speak in favor of the active nature of the phenomenon, is not commonly observed except when it can be due to other causes which disturb the biliary flow.

Lastly, the morphological changes of the duct can be determined by any factor which permits bile to penetrate the pancreatic duct during a certain length of time.

According to Mirizzi's hypothesis, the functional disorder which allows Wirsung's duct to be visualized is due to partial contraction of the sphincter of the papilla during the act of biliary expulsion, while normally it should be entirely relaxed.

Following this line of thought one should admit that if the sphincter of the papilla offers resistance to the bile flow during its partial contraction, this resistance would increase in the case of total contraction; this we have stated is questionable, and consequently so is its participation in these dyskinetic conditions. The penetration of bile in the pancreatic canal can be produced by any cause existing in the ampulla of Vater that impedes the flow of bile; this need not necessarily be a stone or a contraction of the sympathicotrophic segment of Oddi's sphincter; it can be of any other nature.

Histology of the ampulla of Vater in pathological cases has taught us that cer-

tain anatomical alterations may be present which obstruct the passage of bile and may favor its penetration into Wirsung's duct.

In Vater's ampulla, there exist normally mucosal folds that not only act as valves impeding the backward flow of bile but are also capable, when very marked, of opposing certain resistance to its passage (Fig. 11).

Even more important is the hyperplasia of the mucosa, reaching occasionally such development that one must admit it as a factor capable of promoting penetration of bile into the pancreatic duct (Fig. 12).

We do not wish to signify that these



FIG. 11. Longitudinal section of the ampulla of Vater and the biliary and pancreatic ducts. On the left the choledochus, on the right Wirsung's duct. Note at the level of the ampulla, the existence of valves whose function it is to impede the reflux of bile, but which, being overdeveloped, offer some resistance to its natural flow, thus causing reflux into the pancreatic canal. In this observation a well developed valve may be seen at the end of the septum between the choledochus and Wirsung's duct, capable of closing the entrance to Wirsung's duct and obstructing the passage of bile into it.



FIG. 12. Transverse section of the ampulla of Vater near its middle portion.  $\times 10$ . Note the considerable increase of accessory glands which almost close the lumen of the canal.

reasons are valid in every case; we only propose that they be taken into account when the causes that favor reflux are under discussion.

The sphincter of the choledochus is, as has been stated, the more important part of the muscle of Oddi, and in accordance with Schwegler and Boyden we accept that "it is this muscle which causes repletion of the gallbladder during intervals between meals, and which, when overstimulated during certain physiological and pathological conditions, produces clinical entities known as dyskinesias or dysnergias of the biliary tract."

This musculature is usually hypertrophic in those cases in which the gallbladder is not functioning or when there is lithiasis of the main duct.

Roentgenologically the contraction of this annular muscle is frequently observed, suddenly detaining the opaque column, giving rise to a variable image.

This generally adopts the shape of a thimble with its convexity downwards, and if some contrast medium has passed into the duodenum, it is separated from it by a variable space (Fig. 13).

Sometimes the contracted sphincter produces in the terminal portion of the choledochus an infundibular image, ending in a more or less blunt point (Fig. 16 and 17).



FIG. 13. Postoperative cholangiogram. Twenty cubic centimeters of 40 per cent abrodil. The sphincter of the choledochus is contracted, and the terminal portion of the bile duct shows a thimble-shaped image with an inferior convexity. Wirsung's duct has filled, but its terminal portion which lies parallel to the choledochus is not shown. The pancreatic canal shows a suspended image.

Less frequently, the last part of the biliary duct ends abruptly at right angles.

It is easy to see that, when Wirsung's duct is visualized while the sphincter of the choledochus is contracted, part of the pancreatic duct which runs parallel to the choledochus is not visible. The explanation is that the fibers that surround the pancreatic duct while it is in contact with the bile duct are common to both, and their contraction occludes them simultaneously; thus only the proximal part of Wirsung's duct is visible, as it lacks muscular fibers (Fig. 13).

We have already mentioned that the contraction of the choledochus detains the bile column.

Roentgenographically this can be ob-

served: when this muscular group is contracted, the terminal portion of the choledochus is seen at a higher level than that which corresponds to the junction of the biliary and pancreatic canals. This space corresponds to the contracted sphincter and it may well measure its length (Fig. 13, 14 and 15).

When the sphincter of the choledochus is relaxed one can then see the terminal portion of the biliary duct which varies normally between 8 and 15 mm.

This portion usually has the appearance of a canal which gradually narrows until it opens into the duodenum; this should not surprise us if we remember that the intestinal part of the choledochus diminishes progressively in caliber as it approaches the ampulla of Vater.

This canal can follow the direction of the duct and originate symmetrically from the



FIG. 14. Postoperative cholangiogram. Twenty cubic centimeters of 40 per cent abrodil. Sixty seconds afterwards a second cholangiogram is taken. The sphincter of the choledochus starts to relax allowing the passage of the medium into the duodenum.

dilated portion above, or deviate or be eccentrically situated with regard to the upper segment (Fig. 15).

In pathological biliary tracts, it is frequently seen that the caliber of this segment is so diminished that it is converted into a filiform pathway; this can be explained knowing the changes undergone by the anatomical elements of its walls, of which the most interesting in our opinion is hyperplasia of the mucosa, which by increasing its thickness reduces the lumen very considerably (Fig. 17). Roentgenographically these images are easily mis-



FIG. 15. Postoperative cholangiogram. Twenty cubic centimeters of 40 per cent abrodil. Three minutes afterwards a third cholangiogram is taken; the sphincter of the choledochus has relaxed completely emptying the biliary and pancreatic tracts. Compare this cholangiogram with Figure 13 and note that the terminal portion of the choledochus is visible in the latter at a higher level than what corresponds to the function of the biliary and pancreatic ducts, as may be seen in this cholangiogram. This space corresponds to the part of the biliary duct surrounded by the muscle of the choledochus, and may well measure its length.



FIG. 16. H. C. 47-977. Postoperative cholangiogram. Ten cubic centimeters of 40 per cent abrodil. Cholangiogram taken one minute after giving the injection. The sphincter of the choledochus is contracted. The last portion of the bile duct gives an infundibular image ending in a blunt extremity.

taken for those given by constricting pancreatitis.

Inversely, in some cases this portion of the duct is visible as a canal only slightly narrower than the part of the choledochus above the sphincter, allowing a very rapid passage of the contrast medium, thus making visualization of the biliary tree difficult. In these circumstances, a slight degree of muscular atony should be suspected, allowing of rapid emptying (Fig. 18 and 19).

Visualization of the ampulla of Vater is always difficult; however, sometimes it can be distinctly seen, when it has emptied and only a small amount of opaque substance delineates its outline.

These images described, which correspond to the contractions and relaxations of the sphincter of the choledochus, have been thus interpreted by us, and confirmed



FIG. 17. H. C. 47-977. Postoperative cholangiogram. Twenty cubic centimeters of 40 per cent abrodil. Ten minutes after the injection was given the sphincter of the choledochus has relaxed, showing a filiform canal.

by the histological study carried out by one of us; so it is surprising to us to find that they are often attributed to dyskinesia and pancreatopathy.

The sphincter of the choledochus is held responsible for biliary retention when the surgeon cannot find during the operation either calculi, pancreatic lesions, or any other known cause to explain the disturbance.

These cases of jaundice have been attributed to obstructions in the free biliary circulation and localized in the last part of the choledochus, and may be functional and organic.

Cholangiography can afford useful lessons in these cases, especially when a prolonged stasis of the contrast medium is found. The image of the terminal portion of the bile duct is, in our judgment, much less important.

Difficulties begin when one tries to determine the cause of the biliary retention. A halt in the opaque column may be due to a normal contraction, a spasm of the sphincter or an anatomical lesion of the walls of the final segment of the choledochus, which obstructs its lumen, excluding naturally an obstacle such as neoplasm, stones or extrinsic compression.

Roentgenologically there is no difference between the appearance of a normal contraction and that of a spasm of the sphincter; the latter is to be suspected when there is a stasis lasting fifteen or twenty minutes. But is that period of time sufficient to differentiate the normal from the pathologic? Cannot a contraction of the sphincter be of a longer duration than usual and still have no abnormal significance? And is not this supposition more probable when one is dealing with diseased bile tracts?

Most of the ducts we examine by this method are pathological, with evident alterations in the structure of their final portion; it is only logical to think that they jeopardize the normal function of the sphincter.

This, we believe, is how the hypertrophy of the musculature of the sphincter acts, which is so frequent when the gallbladder is excluded from functioning.

This increase of muscular tissue can easily be a cause of hypertonia of the sphincter, and should be considered an adaptation to the new physiological conditions imposed upon the main bile path, and which is compatible with perfect health.

It is possible that this increased obstacle to the flow of bile determined by an increase of tone of the sphincteric musculature is not permanent. This is proved by certain patients in whom it appeared in the first examination, but one or more days later the contrast medium passed into the duodenum easily a few minutes after injection.

Evidently, the problem existent in these cases is a complicated one, and we admit that it cannot be solved with two or three roentgen examinations at short intervals,

or with only one examination, because results may be entirely different on repetition.

There are no doubt cases in which it is not a functional factor which determines the biliary stasis, but certain abnormalities of the distal portion of the choledochus which give rise to canalization difficulties of a permanent nature capable of disturbing the flow of bile.

Microscopic anatomical studies of the pathological ducts have shown us the existence of serious structural modifications, such as hyperplasia of the accessory glands, which growing toward the lumen of the canal, narrow it as much as to almost make it disappear in given sections; the sclerosis of the mucosa which in the shape of fibrous



FIG. 18. H. C. 11.672. Postoperative cholangiogram. Twenty cubic centimeters of 40 per cent abrodil. The relaxation of the sphincter of the choledochus has not allowed the biliary tract to fill, as the contrast medium has passed rapidly into the duodenum. Twenty cubic centimeters more of abrodil was injected, with greater pressure, and Figure 19 was taken.



FIG. 19. H. C. 11.672. Postoperative cholangiogram. Twenty cubic centimeters of 40 per cent abrodil. The terminal part of the biliary duct is wide open, and its caliber appears only slightly narrower than that of the remainder of the duct. In the left branch of the hepatic duct the images of two calculi can be seen.

bands fills the space between crypts and glandular ducts; the sclerosis of muscular tissue and the hypertrophy of musculature which is sometimes so intense that the greater part of the duct is formed by it.

These morphological changes, by themselves or associated with functional disorders, may cause cholestasis and probably each inflammatory episode increases this impediment by hyperemia and edema.

This explains certain syndromes of the choledochus without stones in the main biliary tract, and even cases of cholelithiasis in which the calculus does not participate mechanically in the obstruction (Fig. 20).

Finally we will refer to the motility of the biliary tract.

If the motor function of the accessory



FIG. 20. H. C. 11,066. Postoperative cholangiogram.

Twenty cubic centimeters of 40 per cent abrodil. M. G., aged forty-one. The first painful episode, accompanied by jaundice, appeared at the age of thirty-eight, passing off after three months of medical treatment. Three months ago another crisis of pain, jaundice and remaining signs of retention of pigments and salts became manifest. An operation was performed on June 1, 1940, with the diagnosis of lithiasis of the hepatocholedochus. The gallbladder contained no calculi, but was cut off from the biliary circulation. A dilated choledochus was found to contain a large amount of inspissated bile and sediments; probing did not reveal calculi but the terminal portion could not be catheterized. There was no evident alteration of the pancreas. A cholecystectomy and drainage of the biliary tract with Kehr's tube were performed. Fifteen days later roentgen study of the bile duct showed a delayed passage of the contrast medium into the duodenum. This result was obtained in successive explorations which made us suspect the existence of stenosis of the duct. The patient was finally cured after a bilidigestive anastomosis was performed.

tract is no longer questioned, that is not the case with the principal one; here once again there arises a difficulty in discussion as regards microscopic anatomy and cholangiography.

Muscular tissue, with the exception of that of the sphincter of Oddi, is present in the conductive system in so small a quantity that its functional importance is nil. Histology has shown that the muscular elements that participate actively are isolated longitudinal bundles, separated by large zones where that tissue is absent.

The choledochus, particularly, has the greater amount of muscular fibers, especially in the distal portion of the duct.

The circular fibers are scarcer than the longitudinal ones; they are scarcer in the hepatic duct than in the choledochus; in this duct, they are more numerous in the lower part of its extramural portion. Knowing the quantity and distribution of this tissue, we do not believe it probable that it can convey motility to the biliary canal.

Lütken, in a chapter concerned with the histology of the conductive system, says, referring to the scarcity of muscular fibers in the hepatic ducts, that "it is impossible to attribute any special functional importance to these scanty elements"; and goes on to say that in the choledochus only the muscular bundles near the sphincter can cooperate in the act of bile expulsion.

Nuboer, speaking of the factors which cause the passage of bile into the intestine, refers to the muscular contraction of the common duct, among others, and says that "the small quantity of muscular fibers and the length of the canal make this supposition most improbable."

In favor of the unimportant part that the muscular element plays in the principal biliary tract, we mention the fact that in those cases in which there is an obstruction in the last portion of the choledochus, cases which should show a functional hypertrophy of the musculature, it is not markedly increased.

Only in a small number of cases, one must admit a certain motility, localized in the distal part of the choledochus, which is where there is greater development of the musculature and especially of circular muscle fibers.

Roentgenologically, we have seen, though very rarely, certain irregularities of the



borders of the canal, located at that level, which must be interpreted as waves of contraction (Fig. 21 and 22).

Other modifications of the images which have been described as characteristic of the existence of motility are due, we believe, to errors of interpretation related to the quantity and quality of the contrast medium used.

The use of a small amount of the contrast medium and the employment of very viscous substances can produce these images, as we have found in cholangiograms of



FIG. 21. H. C. 12.455. Postoperative cholangiogram. Thirty cubic centimeters of 40 per cent abrodil. Note in the terminal portion of the choledochus certain irregularities in the borders of the duct which must be attributed to contractions of the circular muscle fibers existing at this level. In favor of their active nature there is the fact of their disappearance in the next roentgenogram (Fig. 22) taken one minute later. The dome-shaped image appearing in the terminal portion of the choledochus is not due to a stone, as it is not present in Figure 22. This cholangiogram was taken twenty minutes after injection of the opaque medium; up to that time no passage into the duodenum had taken place.



FIG. 22. H. C. 12.455. Postoperative cholangiogram. Thirty cubic centimeters of 40 per cent abrodil. Taken one minute after Figure 21. The terminal portion of the choledochus shows regular borders; the dome-shaped image has disappeared and opaque medium passes into the duodenum.

the cadaver, where of course no activity can be invoked.

#### SUMMARY

Cholangiography is at the present moment a means of investigation which permits exploration of the biliary tree, with the object of verifying the existence of calculi, studying the permeability of the terminal portion of the duct, its abnormalities, apart from being a useful aid for the study of the physiopathology of the bile ducts. But it does not always fulfill its task satisfactorily, as often uncertainties appear and errors are committed because cholangiography is not infallible.

Two main problems are considered here:

1. Cholangiography related to lithiasis of the hepatocholedochus.
2. Cholangiography applied to physiopathology of the principal biliary tract.



After describing the appearances that allow us to diagnose the existence of an intracanalicular concretion, the uncertainties and errors, which make their appreciation difficult, are taken up. They originate either by faulty interpretation or because roentgenography does not permit the visualization of the foreign body. The former are called errors of interpretation; the latter, errors of omission.

Errors of interpretation are committed when there is difficulty in the correct appreciation of the images seen; they are caused by faulty technique, abnormalities of the biliary tract, edema due to cholecystitis, superposition of the duodenal shadow, or deformities by compression of the vertebrae. Errors of omission are committed when the roentgenogram does not reveal the existence of an intracanalicular calculus, and are due to defective distribution, excess or small amount of the contrast medium used, to the employment of substances of great opacity or a lack of proportion between the stone and the caliber of the duct.

We have taken up the physiopathology of the bile ducts by cholangiography, based on knowledge obtained by microscopic anatomy of the ducts.

In the first place, the problem of reflux of the medium into Wirsung's duct is considered, analyzing afterwards the images of the terminal portion of the choledochus, which is surrounded by a sphincter of its own; it is confirmed by roentgen examination that it is this muscle which stops, by its contraction, the flow of bile, and maintains the pressure in the interior of the duct.

The debated question of the functional disorders of the muscle of Oddi is the object of special study, pointing out the difficulties encountered in establishing its diagnosis with the sole aid of cholangiography. Many spasms of the sphincter must be considered

intimately related to the anatomical alterations of the sphincteric musculature, which is generally hypertrophic in diseased biliary canals. This functional hypertrophy, capable of causing hypertonia of the sphincter, is compatible with perfect health.

There are other cases in which the disorder of canalization is not due to a functional cause, but to a number of organic alterations, which generally coexist and prevent free circulation of the bile.

Finally, reference is made to the motility of the main bile tract, precluding this duct from any peristaltic activity, except the lower part of the extramural portion of the choledochus, where motility can sometimes be observed.

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# MARCH FRACTURE

## AN ANALYSIS OF 166 CASES

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SINCE the condition was first described by Breithaup, in 1855, numerous cases of march fracture have been reported in the European literature. In recent times, however, coincident with the growth of our armies, substantial series of march fractures have been reported in American journals.

The term "march fracture," as it is generally understood, applies to those fractures of the metatarsal bones which occur without great trauma, during a march.\*

From April 1, 1941, to June 10, 1943, we have had the opportunity of studying 166 cases of march fracture of the metatarsal bone, and because of the frequency of this condition, we have become interested in its etiology and pathogenesis.

All current theories concerning the production of march fractures give due importance to the small repeated traumata incurred in long marches. All authors, however, agree that some other factor must be concerned before march fractures occur. "Physiologically inadequate" feet, abnormal length of the fractured metatarsals, overload, neurogenic influences, inflammatory processes, and the handicap of a previously sedentary occupation of the patient have been mentioned as possible causative factors.

In our cases, we have made an effort to evaluate these possible causes, and, in addition, we have studied calcium and phosphorus metabolism in 12 cases, with the possibility in mind that an altered bone nutrition might have had some influence in the production of the fractures.

\* We have seen two march fractures of the pubes, one of the femoral neck, and one of the supracondylar area of the femur during the past twenty-five months.

In 20 of our cases, we were also able to secure accurate information as to the time that the fractures occurred after the beginning of the march.

Our 166 cases of metatarsal fractures occurred in 155 patients—2 had bilateral

TABLE I  
FOOT INVOLVED IN 155 CASES OF MARCH FRACTURES

	Number	Percentage
Right	89	57.4
Left	66	42.6
Total	155	100

TABLE II  
METATARSAL INVOLVED IN 166 MARCH FRACTURES  
(155 patients)

Metatarsal	Number	Percentage
Second	60	36.2
Third	90	54.2
Fourth	13	7.8
Fifth	3	1.8
Total	166	100

fractures and 9 had multiple unilateral fractures.

As seen in Table I, the right foot was involved in 89 cases (57.4 per cent), whereas the left was involved in 66 cases (42.6 per cent). The metatarsals involved were as follows (Table II): first metatarsal, none; second metatarsal, 60 cases (36.2 per cent); third, 90 cases (54.2 per cent); fourth, 13 cases (7.8 per cent), and fifth, 3 cases (1.8 per cent).

Most fractures occurred in the middle and distal thirds of the involved bone. Ninety, or 54.2 per cent, occurred in the distal third; 73, or 44 per cent, occurred in the middle third; and 3, or 1.8 per cent, occurred in the proximal third. The most frequent site of fracture was at the distal third of the right third metatarsal, with 31 cases. There were 29 cases involving the distal third of the left third metatarsal.

The age distribution appears closely correlated to the age distribution in the Army,

ance at the roentgen department for roentgenograms of the foot averaged twenty days, although the extremes varied from a few hours to ninety days. The patients' former occupations ranged from coffin making to dress designing, and did not appear of significance.

The 20 cases were interviewed personally. They reported that they had completed several miles of marching, and that muscle fatigue had set in before the onset of symptoms. The distance marched before the pain of fracture occurred averaged 11 miles.

Sirbu and Palmer<sup>1</sup> have suggested that the so-called "atavistic foot," with a relatively short first metatarsal, is a causative factor in the production of march fractures. On casual inspection of the roentgenograms in our series, all appeared to have appreciable shortening of the first metatarsal. However, careful measurements did not bear out this observation. Fifty normal feet and the 157 feet with march fractures were measured in the following manner (see Fig. 3): A line was drawn from the distal end of the first to the distal end of the fifth metatarsal, utilizing the dorsoplantar roentgenogram. The distance between the point where this line crossed the shaft of the second and the distal end of the second was then taken as an index of the relative shortening of the first metatarsal. This measurement index averaged, in the normal foot, 10.7 millimeters. In the fractured feet this index measured 10.0 mm.

The location of the sesamoid bones, in relation to the distal end of the first metatarsal, appeared likewise to remain practically constant in both normal and fractured feet.

In a further attempt to discover an etiological factor for the occurrence of these fractures (aside from that of repeated sub-threshold trauma), 12 patients were studied from the standpoint of blood chemistry, with the following results (Table III): blood phosphorus (Fiske and Subarrow method) averaged 3.5 mg. per 100 cc. (normal 3-4 mg.); blood calcium (Clark Collip method)

TABLE III  
BLOOD CHEMISTRY IN 12 CASES OF MARCH FRACTURE

Case Number	Serum Phosphorus	Phosphatase	Serum Calcium	Cevitamic Acid
Normal	3-4 mg. per 100 cc.	10 units	9-11 mg. per 100 cc.	0.75 mg. per 100 cc.
1	4.1	8.1	12	0.44
2	3.2	6.2	11	0.51
3	3.7	4.8	10.7	0.54
4	2.9	5.0	10.9	0.61
5	2.8	8.4	11.8	0.47
6	4.0	8.9	11.9	0.81
7	4.4	7.8	9.2	0.40
8	3.02	4.8	11.4	0.50
9	3.6	4.08	11.1	0.42
10	3.8	5.98	11.9	0.54
11	3.7	6.7	11.2	0.68
12	3.1	7.0	11.4	0.47
Average	3.5	6.48	11.2	0.49

and is therefore not considered of significance in the etiology. No neurological disturbances or infections could be discovered in any of our cases.

Prior occupation and length of service were studied in 20 cases in an effort to discover any possible causative factor, such as sudden subjection of a little used foot to strenuous weight bearing and marching activities. Length of service in these 20 cases averaged thirty-seven and one-half weeks. The duration of training time spent taking long hikes and forced marches averaged twenty-seven weeks. The average time between first symptoms and appear-



FIG. 1. *A*, march fracture in distal end of third right metatarsal. *B*, same case, twenty-six days later.

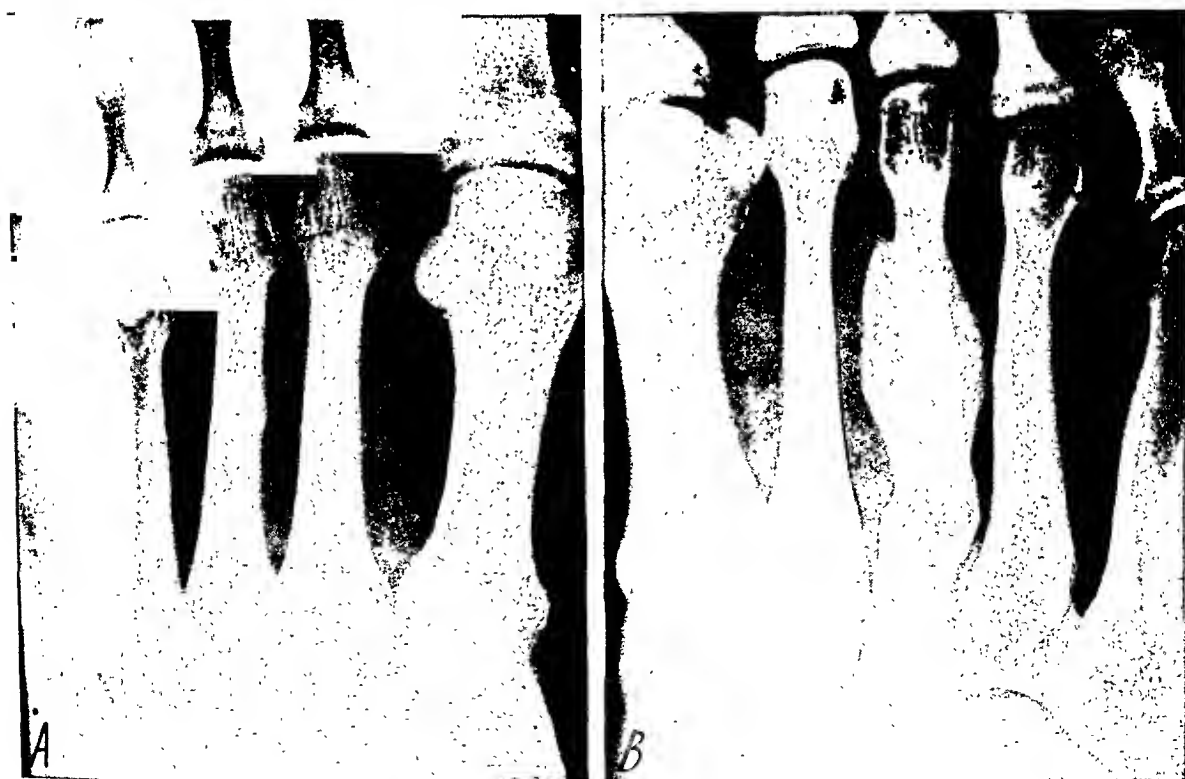


FIG. 2. *A*, bilateral march fractures in white soldier, aged nineteen, right foot; note periosteal proliferation along medial surface of shaft of third metatarsal. *B*, left foot of same patient, roentgenogram taken same day as *A*. Note similarity to osteogenic sarcoma of periosteal type.

averaged 11.2 mg. per 100 cc. (normal 9-11 mg.); fasting cevitamic acid levels averaged 0.49 mg. per 100 cc. (normal 0.75 mg.) with a high of 0.81 and low of 0.42 mg. per 100 cc.

Serum phosphatase levels, as determined by the modified Bodansky method averaged 6.48 units. (The normal in adults is usually considered as any level up to 10 units. Youmans and Patton,<sup>2</sup> however, re-

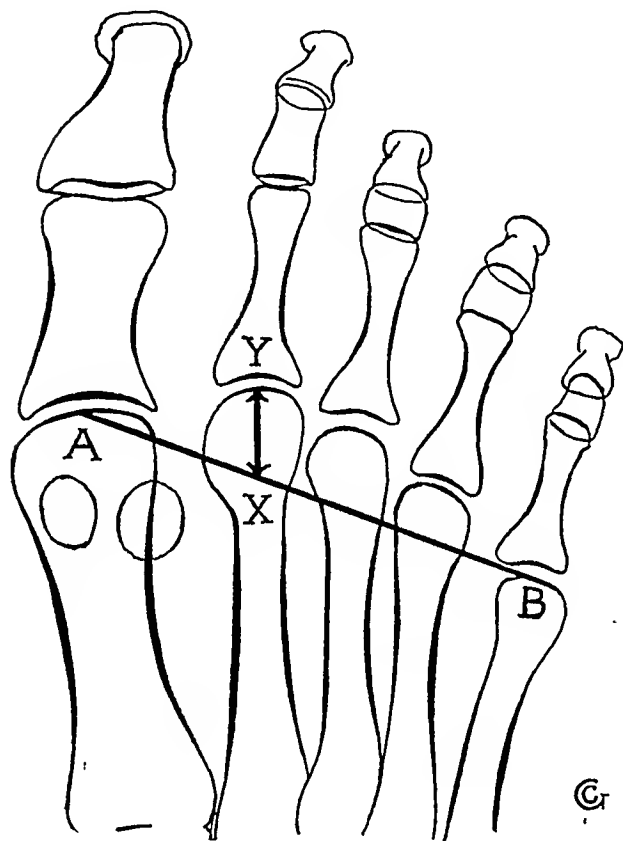


FIG. 3. Diagram to show method of measuring relative foreshortening of first metatarsal. Line *AB* connects the central points of the distal articular surfaces of the first and fifth metatarsals. Line *XY* measures the distance from the point where *AB* crosses the shaft of the second metatarsal to the central point of its distal articular surface.

port values in the general population of from 1.5 to 5.0 units.) The slight increase of phosphatase in our series can probably be considered due to the stimulus of healing fractures.

It is apparent from the study of our cases that age, previous occupation, neurological disturbances, bony anatomy of the feet,

and bone metabolism cannot be considered as important etiological factors, although they may contribute to the production of these fractures in individual cases.

It seems to us that due consideration has not yet been given to the fact that bones cannot stand great stresses unless they are adequately supported by muscle. In the foot we have three complex systems of arches which rely for support on the tone of the plantar muscles and also on the tension of the tendons of the *tibialis posterior* and *peroneus longus*. One of the most important muscles in the foot is the *transverse head of the adductor hallucis*, which arises from the capsules of the lateral four metatarsophalangeal joints and the deep transverse ligaments, and inserts into the base of the proximal phalanx of the great toe. The action of this muscle is to adduct the heads of the four lateral metatarsal bones. This allows for flexibility across the heads of the metatarsals in walking. The heads spread when weight is thrown on them and the muscle acts much as a spring to snap them back to their original position when the foot is relieved of the weight. Loss of resiliency of this muscle would throw unusual strain on the head of the lateral metatarsals.

Anyone who has taken prolonged physical exercises knows how much less efficient muscular contractions become after the experience of fatigue. When muscles of the foot and leg are fatigued, the weight of the body is thrown directly on the metatarsal bones, while the arches are flattened by the loss of muscular tone. In addition to normal stresses which are placed on this weakened system during level marching, there are also additional stresses which occur when marching under a heavy load or over rough ground. As stated before, all of the 20 cases in which information was available experienced fatigue before the pain of fracture occurred. This makes us think that while previous occupation, relative length of the fractured metatarsal, and defective bone metabolism may be contributing factors,

muscle fatigue as it occurs during long marches is the principal cause of march fractures.

In order to illustrate the clinical symptoms, the following case histories are presented:

#### CASE REPORTS

Case 1. A white soldier, aged twenty-two, entered the hospital on May 26, 1943, because of pain in his right foot. He had been in the service

and he entered the hospital for orthopedic and roentgen examination.

His parents were both living and well. Prior to induction he had worked as a mattress maker necessitating standing eight hours daily. He had had no fractures previous to this time. He stated that he ate vegetables, fruits, and the regular Army diet, gaining 20 pounds in the seven months of his service.

Roentgenograms of the foot revealed a complete, slightly comminuted transverse fracture

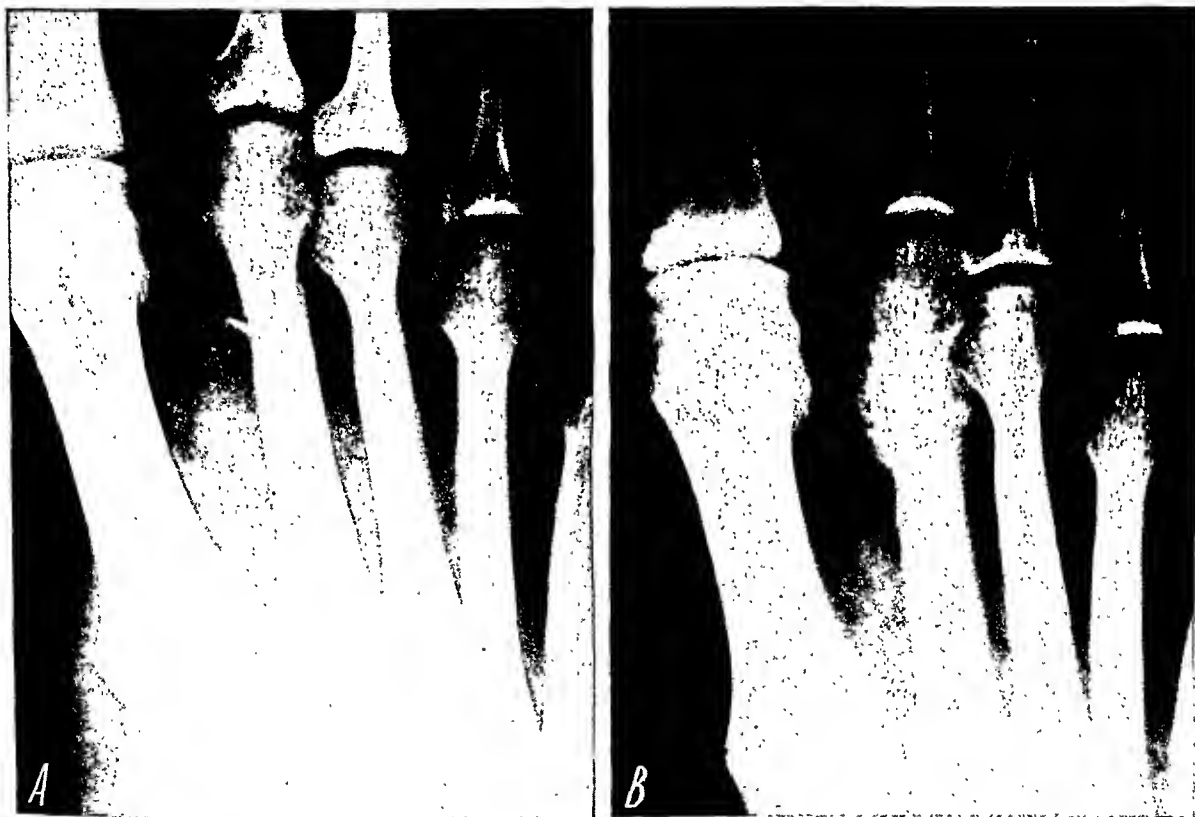


FIG. 4. Case 1. *A*, right foot, May 26, 1943. March fracture of distal end of second metatarsal. *B*, twenty-three days later.

seven months, during which time long hikes and forced marches had been a part of the routine training. Four days prior to admission, while he was on a 6 mile hike with full pack, he began to suffer dull aching pain over the dorsum of the right foot, localized over the second metatarsal area. The pain occurred while the soldier was walking over level ground and it did not radiate. He continued the hike, and the following morning there was swelling over the dorsum of the foot and walking was painful. He was inactive for three days, during which time the swelling subsided. However, pain on walking persisted

2.5 cm. proximal to the distal end of the right second metatarsal, with 2 mm. plantar displacement of the distal fragment (Fig. 4*A*).

Laboratory findings were as follows: erythrocyte count, 5,120,000; leukocyte count, 7,850; Kahn reaction negative; sedimentation rate normal; urinalysis negative. Blood chemistry: phosphorus, 2.9 mg. per 100 cc.; phosphatase, 5 units; calcium, 10.9 mg., and cevitic acid, 0.61 mg. per 100 cc.

A metatarsal bar was added to his shoe and the shoe used as a splint. A follow-up roentgenogram twenty-three days later revealed

exuberant new bone formation about the site of the fracture (Fig. 4*B*). His clinical course paralleled the roentgen findings and he was discharged after twenty-eight days' hospitalization, with the recommendation that he be excused from marching for one month.

CASE II. A white soldier, aged twenty-one, entered the hospital on May 29, 1943, because of pain in his left foot. Ten days prior to admission, after making 16 miles of a scheduled 25

tarsal, interpreted as a march fracture of some duration (Fig. 5*A*).

The patient had been a punch press operator prior to induction, working on his feet for eight to ten hours daily. He had had a fractured rib seven years earlier. He had had five months' service, all of which was spent in strenuous physical training, including long marches and forced marches.

One brother died of nephritis, but both par-

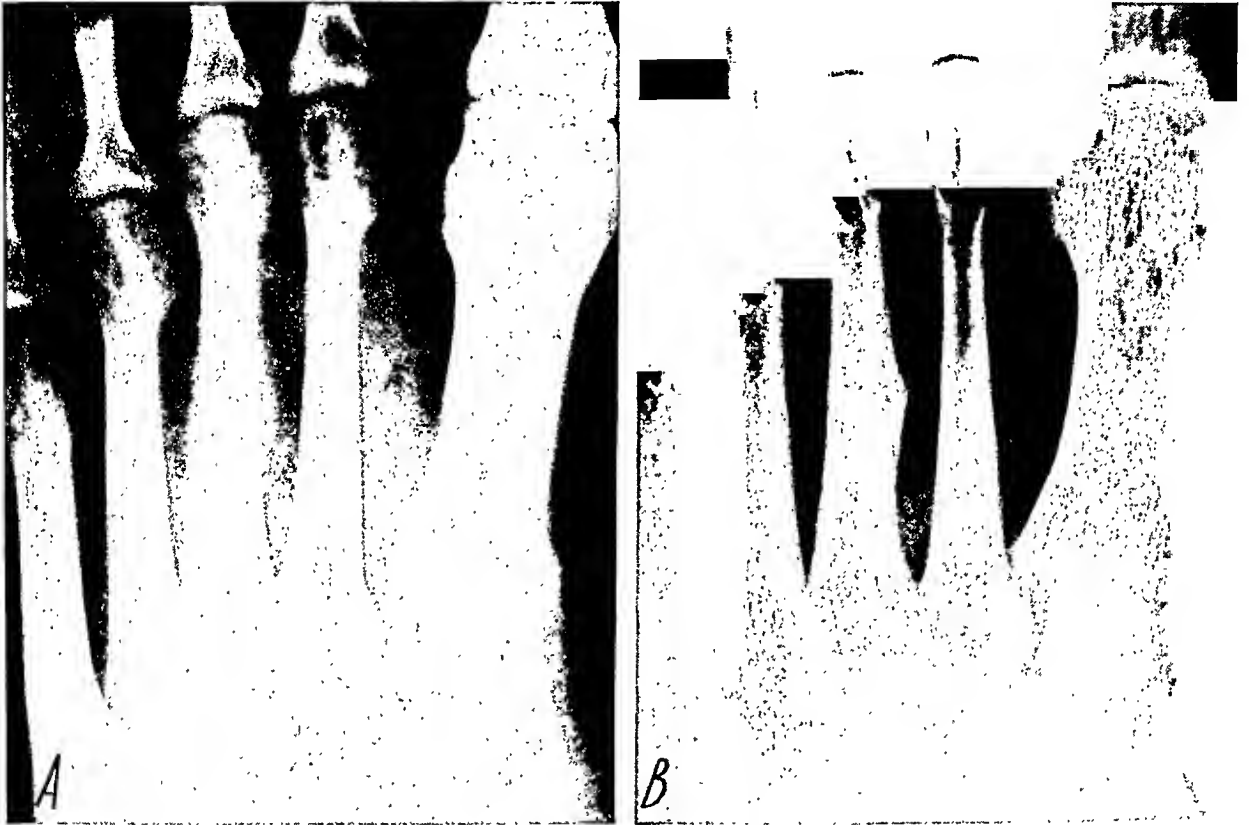


FIG. 5. Case II. *A*, left foot, May 29, 1943. March fracture of mid-shaft of left second metatarsal. *B*, eighteen days later.

mile hike with full pack, he began having a dull aching pain on the dorsal and plantar surfaces of his left foot, in the region of the metatarsal arch. This aching pain radiated to his ankle and the calf of his leg so that he was forced to fall out. The following evening he attempted to go on another hike, but the pain and swelling of the left foot caused him to again fall out. Tape support was applied and the soldier managed to do light duty for ten days, at the end of which time he came to the hospital for orthopedic and roentgen examination. The latter revealed a spindle-shaped periosteal reaction about the mid-portion of the shaft of the left third meta-

ents and seven siblings are living and well. The patient claims he eats all regular Army food, including fruits and vegetables.

Laboratory findings: erythrocyte count, 5,300,000; leukocyte count, 9,500; Kahn reaction negative; urinalysis negative; normal sedimentation rate. Blood chemistry: phosphorus, 3.7 mg. per 100 cc.; phosphatase, 6.7 units; calcium, 11.2 mg., and cevitic acid, 0.68 mg. per 100 cc.

Patient was given sixteen whirlpool treatments and used his G.I. shoes as a splint. After eighteen days, a follow-up roentgenogram revealed considerable new bone formation about

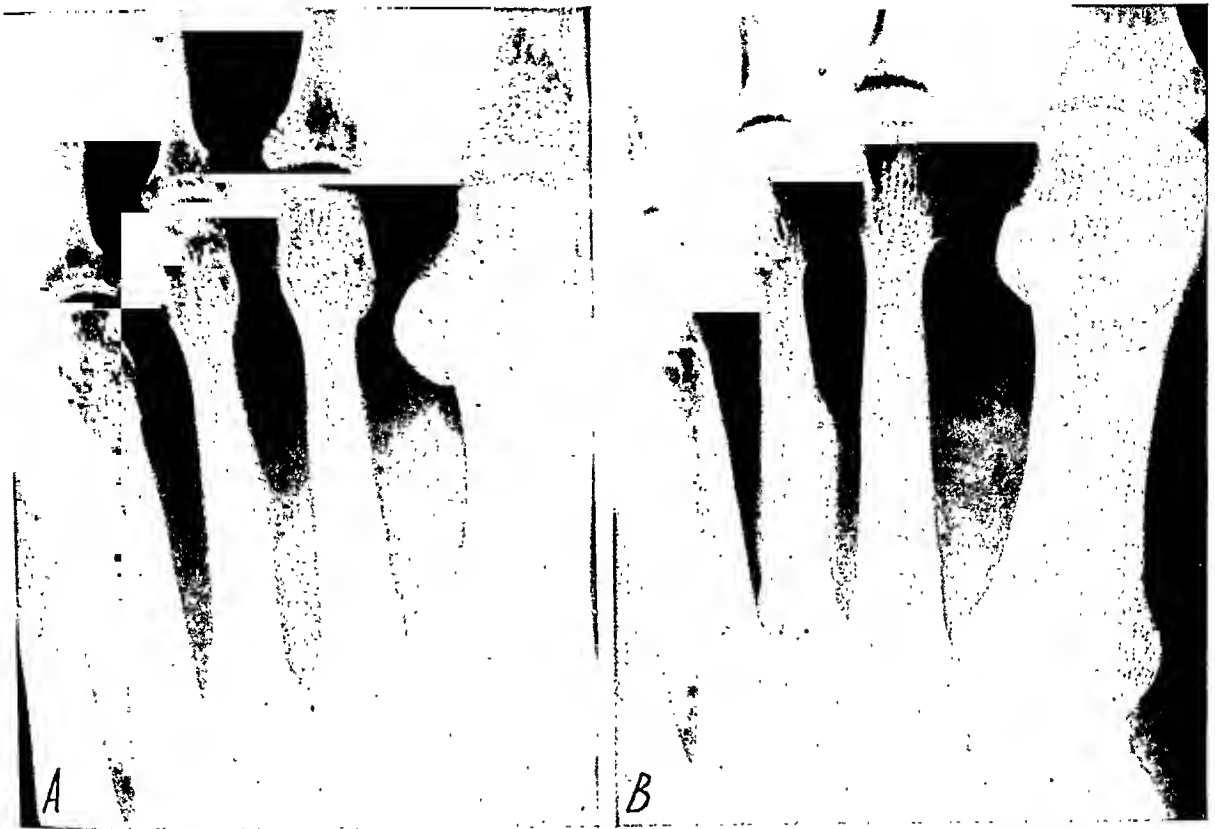


FIG. 6. Case III. *A*, left foot, June 2, 1943. Periosteal proliferation along medial surface of shaft of left third metatarsal. *B*, fourteen days later.

the mid-portion of the shaft of the metatarsal (Fig. 5*B*). The patient was improved clinically, and discharged to duty after three weeks' hospitalization.

**CASE III.** A white soldier, aged thirty, entered the hospital on June 2, 1943, because of pain in the left foot, aggravated by marching. Five days prior to admission, while on a 16 mile hike with full pack, he noticed the onset of a burning and aching pain over the dorsum of his left foot, but continued marching. After twelve hours the foot began to swell on both the plantar and dorsal surfaces, becoming tender to shoe pressure over the mid-portion of the third metatarsal. He continued marching for two days, then came to the hospital.

The soldier had been in the Army fourteen and one-half months, fourteen of which had been spent in physical training, including long marches. Prior occupation was farming. His father died of cancer at the age of fifty. His mother and three siblings are living and well. He states that he eats regular Army food, with generous amounts of fruits and vegetables.

Roentgenograms revealed periosteal proliferation and a fine fracture line through the superomedial surface of the mid-portion of the shaft of the left third metatarsal (Fig. 6*A*).

Laboratory findings: erythrocyte count, 4,800,000; leukocyte count, 8,050; sedimentation rate normal, and Kahn reaction negative. Calcium oxalate crystals were found in the urine on one examination only, otherwise urinalyses were negative. Blood chemistry: phosphorus, 3.02 mg. per 100 cc.; phosphatase, 4.8 units; calcium 11.4 mg., and cevitamic acid, 0.50 mg. per 100 cc.

After fourteen days a follow-up roentgenogram revealed extensive new bone formation along the proximal two-thirds of the shaft of the left third metatarsal (Fig. 6*B*), and the patient remains hospitalized at the time of this writing.

#### SUMMARY AND CONCLUSIONS

1. A study of 166 cases of march fracture of the metatarsal bones is reported.



2. Possible etiological factors were studied.

3. The authors believe that increased stress on the metatarsal bones, induced by muscular fatigue, is the most important factor in the production of such fractures.

Photographic prints were made by Mrs. Herbert Beach, Jr., R.T.

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# ROENTGENOGRAPHIC STUDIES OF THE CERVICAL SPINE

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THE cervical spine is designed primarily to allow extremes of mobility while supporting the weight of the skull balanced on a relatively narrow base. At the same time its foramina transmit the roots of the brachial plexus. These peculiarities of structure and function predispose this level of the spine to sprains, partial dislocations, and nerve root irritation more than the lower, more stable, weight-bearing portion.

## THE ANTERIOR CURVE

A lateral roentgenogram of the normal cervical spine at rest reveals the bodies arranged in a symmetrical anterior curve. Their posterior surfaces form the anterior wall of the spinal canal while its posterior wall is marked by the sections of the arches at their mid-point. These likewise are arranged in a symmetrical anterior curve. The diameter of the canal increases from below upward toward the base of the skull to accommodate the medulla. In the absence of trauma the cervical spine maintains its anterior curve even in cases with advanced arthritis or disc degeneration.

Upon anterior flexion of the normal neck, the curve is reversed but it always remains symmetrical at all points. In the cadaver specimen it is impossible even by counter pressure to produce angulation at one point without cutting the posterior joint capsules.

## ANGULATION

Following severe trauma, often of a "snap-the-whip" character, the normal anterior curve may become replaced by angulation of the cervical spine forward at one point. This indicates a partial bilateral subluxation of the corresponding posterior joints usually with muscle spasm.

Cases of recent subluxation may show considerable decrease in the angulation

after receiving appropriate treatment for a few weeks. Lesser degrees of injury may show only as a straightening of the anterior curve, but forward angulation indicates a more severe injury.

It is usually possible to identify the upper articular surface of the joint where it has become displaced forward upon the articular surface below. Also the posterior joint space is wider in back and narrow in front from the forward tipping of the vertebral body. But in posterior displacement the joint is wider in front (see Fig. 1). If the subluxation is recent, no bony bridging has taken place, but after two months, calcification in the anterior longitudinal ligament may begin to bridge the intervertebral space in an attempt to stabilize this weakened level of the spine. The intervening disc may have become thinned. Complete fusion of the adjacent vertebral bodies may result with final absorption of the intervertebral disc (Fig. 2).

Unilateral subluxation is more difficult to visualize but the forward type may present one or more of the following features: (1) shift of the spinous process toward the side of the subluxation; (2) slight increase in the size of the corresponding intervertebral foramen; (3) encroachment of the opposite foramen; (4) displacement of the articular surfaces upon each other as seen in the lateral stereoscopic studies made with a longitudinal shift, and (5) the intervertebral disc space as seen in the posteroanterior view, thicker on the involved side.

The posteroanterior view, according to the method of Jacobs, is made with the patient lying down, on the Bucky diaphragm, forehead on a sand bag, and the head held by a fixation band. The central ray is vertical over the atlanto-occipital joint. The patient moves the jaw rapidly while holding the head absolutely still for a relatively

long exposure. Such a posteroanterior roentgenogram will show not only the alignment of the spinous processes and the thickness of the discs, but also the posterior articulations and the pedicles with their interpediculate distance representing the size of the foramina. In some cases these foramina are constricted and the inter-

Backward subluxation with preternatural mobility may rarely result from previous injury. When this occurs the posterior margin of the upper vertebral body is seen behind the plane of the lower body. In this position the superior articular process from the vertebra below thrusts forward encroaching upon the intervertebral for-

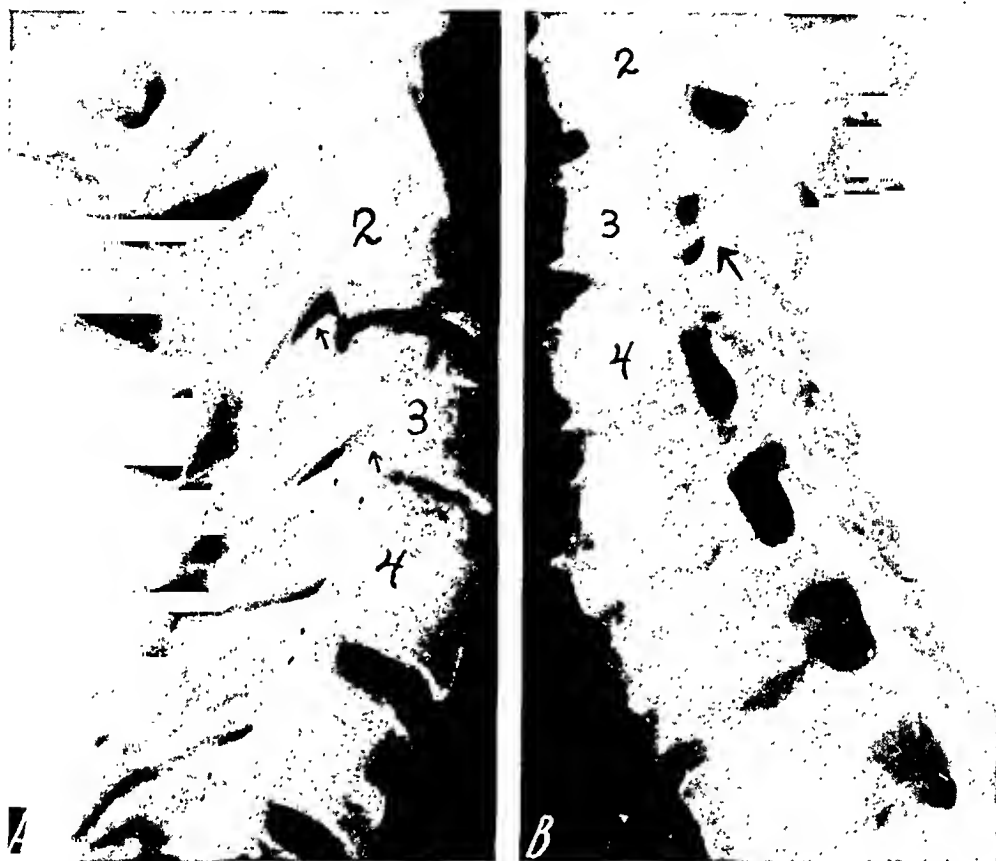


FIG. 1. *A*, preternatural mobility of third body backward on fourth from old injury. Articulation widened in front (arrows). In spite of this condition, note that normal anterior curve is retained. *B*, oblique view showing third foramen encroached upon by superior articular process of fourth (arrow).

pediculate distance is consequently decreased.

In the posteroanterior view, the posterior articulations are seen laterally on each side. They sometimes show an asymmetry in the direction of their planes. Normally the plane of the articulation is transverse and slanting with its upper edge anterior and its lower edge posterior. However, it is not unusual for the articular plane on one side to be more horizontal or more vertical than that on the other. This condition necessarily results in some asymmetry of function.

men. In anterior flexion, the relation between the vertebral bodies is normal (Fig. 1).

#### SPONTANEOUS SUBLUXATION OF THE ATLAS

Children complaining of painful stiff neck usually of sudden onset and without trauma should be examined for this condition. It follows an inflammatory process in the nasopharyngeal region, usually in children, although Wilson has reported one patient sixty-two years old. The spontaneous forward displacement of the atlas on

the axis is thought to be due to a softening of the transverse ligament of the atlas or distention of the bursa between the odontoid process and the anterior arch of the atlas. The child may complain of painful torticollis, supporting his head with the

tance anterior to the spine, and the posterior arch of the atlas is well anterior to the alignment of those below (Fig. 3).

Fractured odontoid process with forward displacement presents the latter two features but there is a history of injury and

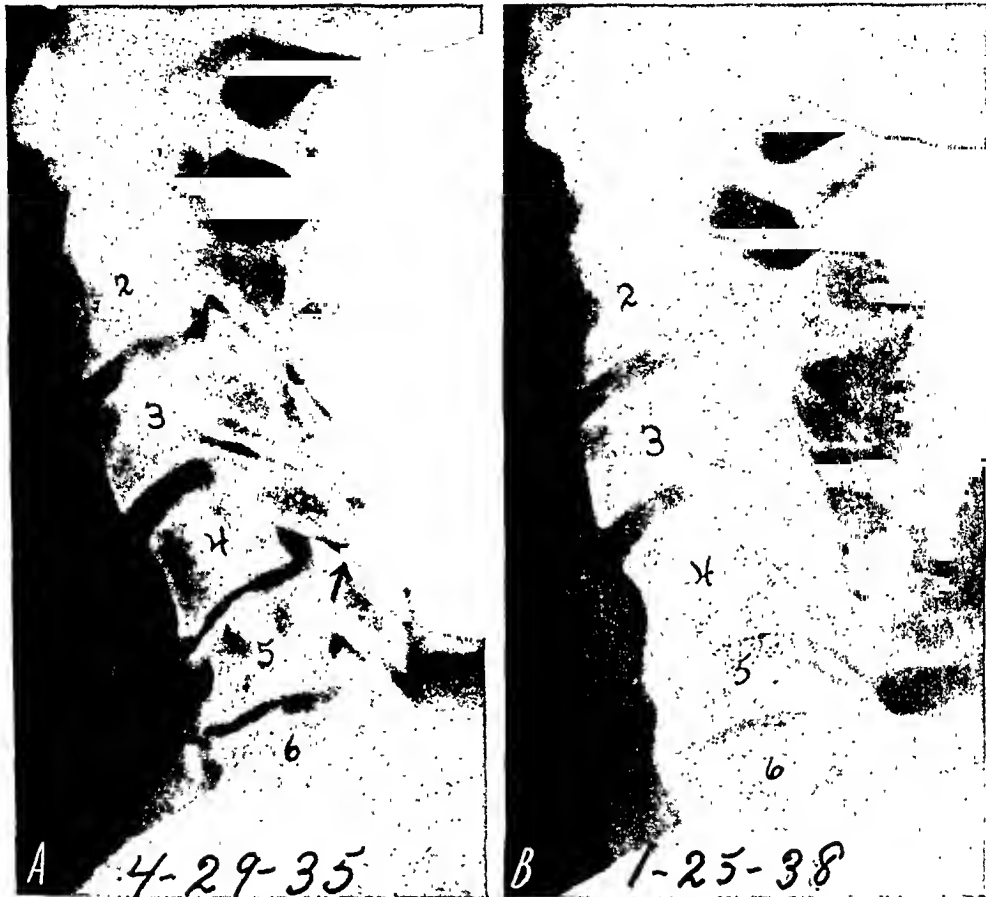


FIG. 2. *A*, traumatic subluxation of fourth cervical vertebra forward on fifth body four and one-half months after automobile accident. Note angulation of bodies, subluxation of posterior joints (arrow) and separation of neural arches at this level. There are compensating subluxations of the third posterior joints in the reverse direction to enable the upper cervical spine to assume the vertical position. Note that the tip of superior articular process of fourth is anterior to normal position. Patient complained of muscle spasm, limitation of motion, local and radicular pain. *B*, same patient two years seven months later. Fusion of fourth, fifth, and sixth bodies—acquired type—posterior joints persist. Continued limitation of neck motion, radicular pain. At end of seven years, patient has complete fusion of these bodies with absorption of disc substance. For oblique view, see Figure 7.

hands. He should be carefully handled during the roentgen examination since death has resulted from careless movement of the head causing pressure upon the medulla.

On the lateral roentgenogram a space is seen between the anterior arch of the atlas and the odontoid process. The odontoid may be demineralized. The ascending ramus of the jaw is more than normal dis-

the anterior surface of the odontoid is well anterior to the anterior surface of the second vertebral body. The treatment is extension and support.

Spontaneous subluxation is not to be confused with congenital torticollis. This latter is painless with sternomastoid spasm of long duration and no forward displacement of the first segment. There is rotation,

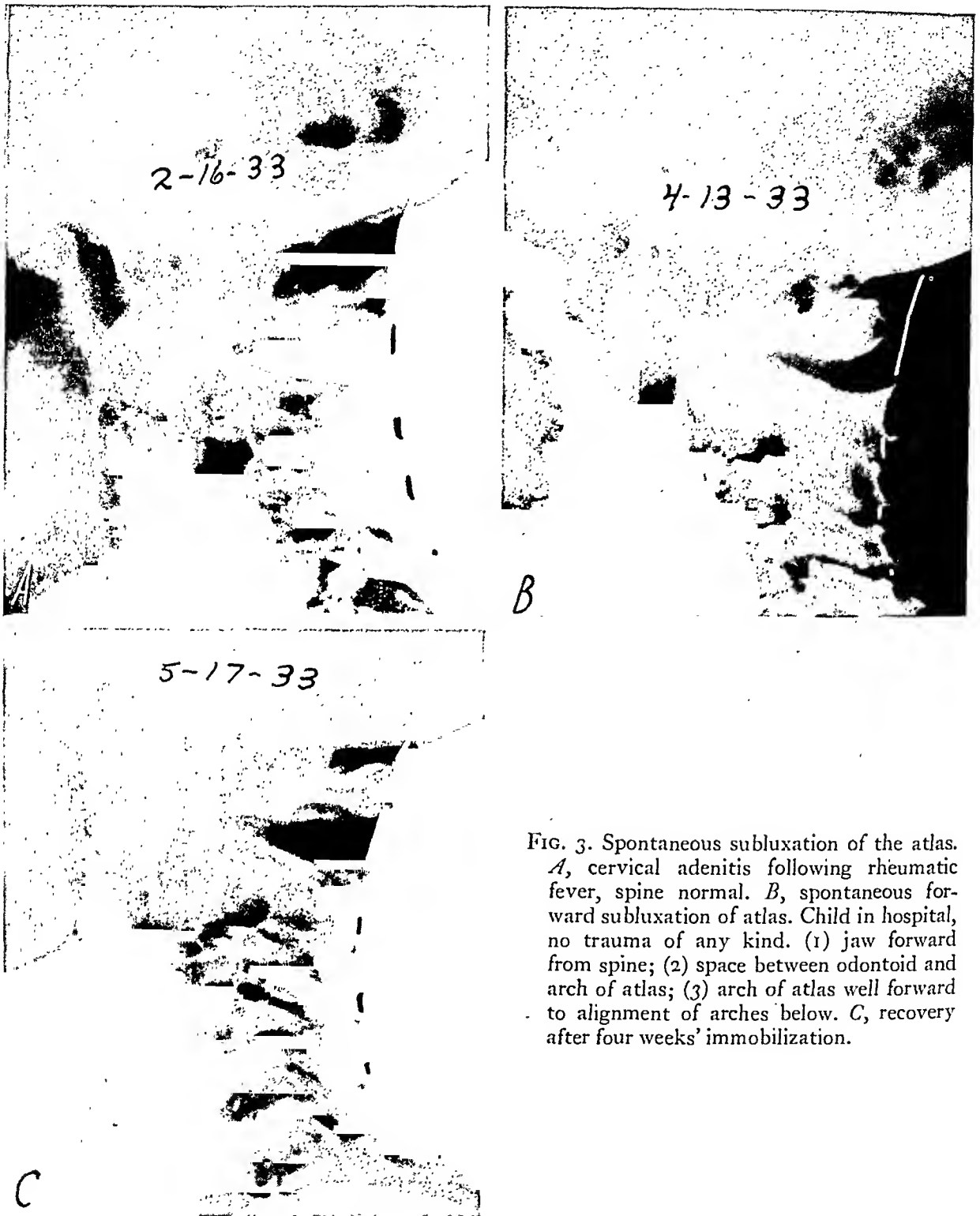


FIG. 3. Spontaneous subluxation of the atlas. *A*, cervical adenitis following rheumatic fever, spine normal. *B*, spontaneous forward subluxation of atlas. Child in hospital, no trauma of any kind. (1) jaw forward from spine; (2) space between odontoid and arch of atlas; (3) arch of atlas well forward to alignment of arches below. *C*, recovery after four weeks' immobilization.

however, of the atlas on the axis which may become straightened upon anterior flexion of the neck. The resulting list of the spine may be compensated for by one of the lateral masses of the atlas being larger than the other. Or if there is a fusion, one side of the block vertebra will be higher than the other. There is likely to be distor-

tion in the shape of the atlanto-axial joint surfaces with the odontoid process displaced to the side against one of the lateral masses of the atlas.

#### ROTATION

Rotation in the upper cervical region is well visualized by stereoscopic base-vertex

axial roentgenograms if the patient is able to lie supine on a level 8 or 10 inches above the plane of the films with the neck extremely dorsoflexed and the vertex of the head resting on the film. The central ray is parallel to the plane of the face but directed at the larynx. Such a technique visualizes the relationship between the base of the skull and the upper two or three cervical bodies (Fig. 4). This also may be done in the vertical position.

In the true lateral view with the two angles of the jaw well aligned the profile of the anterior surface of the second body is seen as a straight line continuous with the odontoid process, but if there is a rotation of the second cervical, the articular surface on the side more forward appears as a triangle lying in front of the second body.

Rotation and scoliosis in the cervical region are both well shown in the stereo-



FIG. 4. Base-vertex view showing rotation of atlas on axis incidental to congenital torticollis. Body of second cervical vertebra indicated by dotted line. First cervical displaced laterally bringing odontoid against its left lateral mass.



FIG. 5. Ossification of the oblique portion of the atlanto-occipital ligament above the arch of the atlas, the so-called ponticulus posterior, arching over the foramen arcuale which gives passage to the vertebral artery and the suboccipital nerve where they pass over the upper surface of the first arch. This structure probably results from the most anterior of the three half somites from which the atlas forms early in embryological life.

scopic posteroanterior "chewing" roentgenograms and are important because these patients are more liable to injury by the "whip-snap" type of accident.

Occasionally in the lateral view one observes a widening of the arch of the atlas with a foramen for the passage of the suboccipital nerve and the vertebral artery. This is the foramen arcuale arched over by the ponticulus posterior or ossified oblique portion of the atlanto-occipital ligament (Fig. 5).

#### FLEXION-EXTENSION STUDIES

Comparative lateral roentgenograms of the cervical spine made at the extremes of forward flexion and dorsal extension will show, in the forward position, the dorsal spinous processes widely separated, while upon dorsal extension they become closely approximated.



FIG. 6. Studies of the cervical spine in extremes of flexion and extension, showing how each vertebral body glides backward and forward on the one beneath it. Note movement in the posterior articulations, also the separation of spinous processes in forward bending.

Arthritis or trauma interferes with this demonstrable movement between the various cervical segments so that either from spasm or fixation the flexion-extension studies may reveal a lack of movement between various segments either at one level or involving the whole cervical spine. That is, two or more of the spinous processes do not separate upon bending forward. Upon subsequent examination it will be found that, in some cases, complete recovery of normal movement has taken place while in others the fixation seems to be permanent. By this method it is possible to furnish roentgen evidence of injury and of progress in recovery even when the roentgenogram does not show evidence of bone or joint injury.

#### GLIDING MOVEMENT

Examination of those cervical vertebral bodies below the second reveals the upper

surface saddle shaped with the lateral margins raised above the level of the central portion. The undersurface of the body represents a section of a cylinder with its axis transverse.

The flexion-extension studies reveal not only a flexion between the bodies with separation of the spines, but also a gliding of each vertebral body backward and forward upon the one beneath it. Measurements show that the point of greatest amplitude of this gliding is about the mid-cervical region. This is the level of maximum disc degeneration noted later in life, and would seem to indicate that probably wear is a factor in producing such degenerative changes (Fig. 6, 29 and 30).

#### THE 45° OBLIQUE TECHNIQUE

In the lumbar and dorsal regions the intervertebral foramina open from the

lateral walls of the spinal canal. In the cervical region, however, they are directed laterally and forward about  $45^\circ$  to the sagittal plane and slightly downward.

The roentgenogram is best made with the patient sitting upright, spine erect, chin up, the occlusal plane of the teeth horizontal, and the shoulder of the side to be visualized against the vertical plate holder. The latter should be at such a height that the upper end of an 8 by 10 inch cassette is on a level with the patient's ear. Use a measuring triangle of thin wood with angles of  $45^\circ$ - $90^\circ$ - $45^\circ$  about 18 inches long on each of the two short sides. By sighting across the triangle downward from above the patient, arrange the transverse plane of the shoulders and the sagittal plane of the skull each  $45^\circ$  to the plane of

the film. The head may be steadied by a small block between the cheek and the plate holder. The target of the tube is about 6 feet directly back of the patient. The central ray is directed toward the mid-cervical region and  $10^\circ$  caudad.

This technique visualizes all of the cervical foramina of that side next the film beginning with that beneath the second vertebra. There is, of course, no intervertebral foramen directly beneath the first segment.

The oblique roentgenogram can also be made with the patient lying on the Bucky table, the sagittal plane of the skull and that between the tips of the shoulders  $45^\circ$  to the table top. The central ray passes vertically from behind and through the atlanto-occipital joint. The patient is well

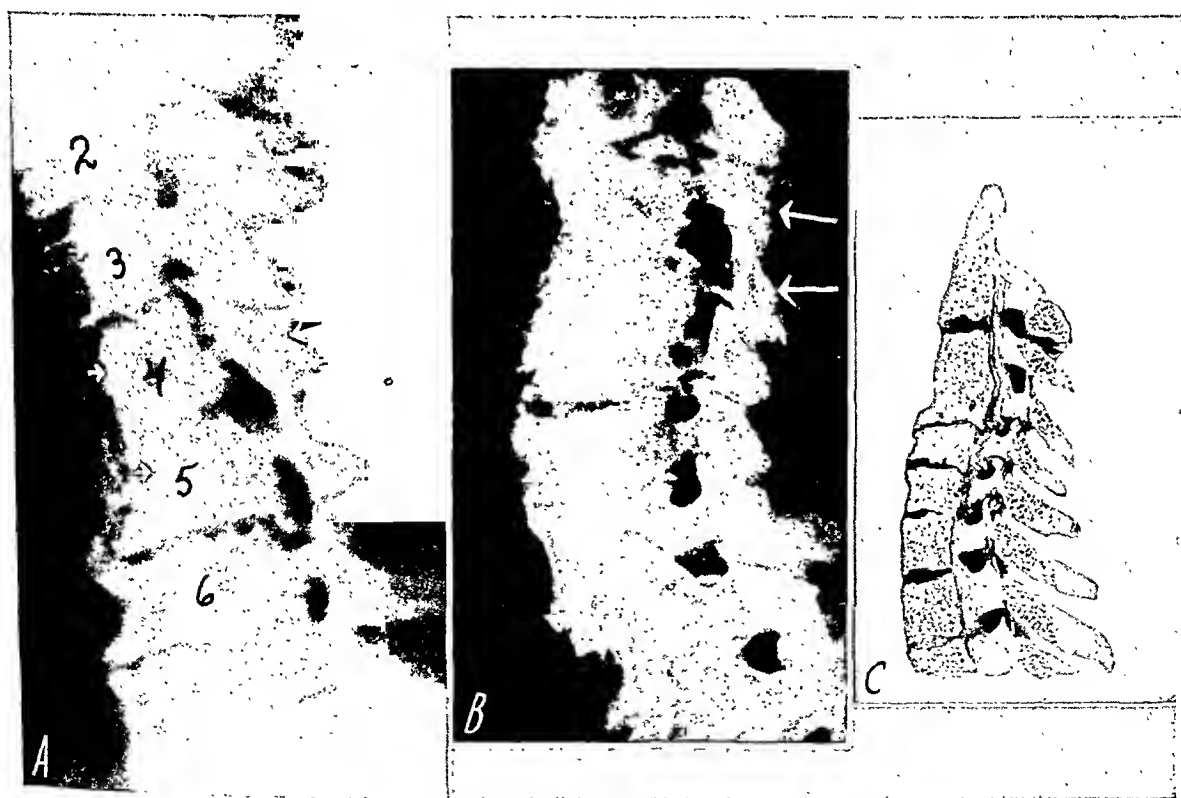


FIG. 7. *A*, oblique view of same patient as Figure 2. Malalignment of posterior arches (large arrow) by forward angulation of fourth on fifth, separation between fourth and fifth arches. Encroachment of third foramen by exostosis from arthritic posterior joint plus forward displacement of fourth superior articular process by compensatory lordosis at 3-4 level. Malalignment of pedicles on opposite side (small arrows). Patient complained of severe radicular symptoms. *B*, oblique view of specimen, *C*, old traumatic angulation. Separation of laminae (arrows) with enlargement of foramen at this level. Other foramina encroached upon by arthritic process of posterior joints and degeneration of the discs. Compare with *A*.





FIG. 8. Sections ( $\times 5$ ) cut from third and fourth cervical discs. *A*, advanced disc degeneration. Cartilage plates fragmented (1); nucleus pulposus replaced by fibrous tissue (2), bony trabeculae (3) and new blood vessels (4) growing from adjacent vertebral bodies into the disc substances. Vertebral bodies nearly in contact at posterior margins of disc (X). *B*, normal cartilage plates (C.P.), nucleus pulposus (N.P.) and annulus fibrosus (A.F.), but destruction of annulus fibrosus at posterior margin of the disc (X). Anterior two-thirds of disc normal.

supported by sand bags and he is asked to move the jaw while the exposure is being made.

#### THE NORMAL OBLIQUE CERVICAL ROENTGENOGRAM

A roentgenogram of the cervical spine made according to the foregoing technique reveals the intervertebral foramina in their normal shape and position. The topmost or second cervical is oval and those below this point are shaped, as Schmorl has de-

scribed, somewhat like the "sole of a shoe." The second and seventh are directed more laterally than those intervening. Each foramen is bounded above and below by a pedicle, in back by a posterior articulation and in front by vertebral bodies and the intervertebral disc.

Posterior to the foramina the laminae of the same side of the arch are seen in section, that is, their cortex in profile. Those for arches, numbers two and seven are oval and larger than the intervening third,



FIG. 9. Female patient with spondylitis deformans. Roentgenogram made in anterior flexion showing movement between occiput and atlas and between atlas and axis but none below. Thickness of discs preserved. There was no encroachment of the intervertebral foramina.

fourth, fifth and sixth laminae which are smaller and more flattened. The posterior articulations are visualized between and partially overlapped by the shadows of the laminae.

In the oblique view of the normal cervical spine, all arches, as well as the foramina, pedicles, and vertebral bodies appear in a smooth, sweeping symmetrical curve about equidistant from each other. Any malalignment in this curve or irregularity in the spacing of the sections indicates a disturbance in the structure of the articulation of the cervical units.

The arch of the first vertebra may normally appear slightly anterior to the curve of the other laminar sections. The dorsal

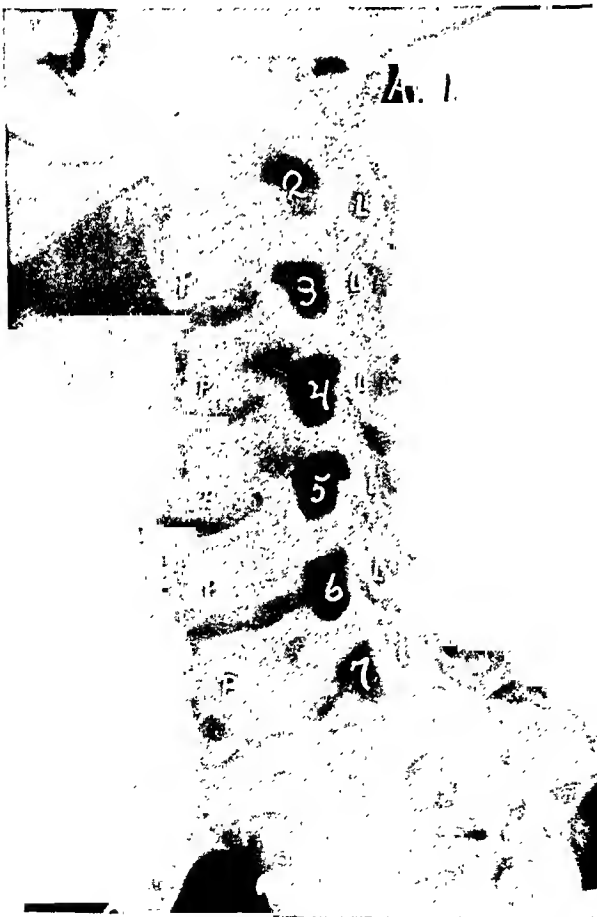


FIG. 10. Normal 45° oblique cervical spine. Note that the laminae (*L*), foramina (numbered), the bodies and the pedicles of the opposite side (*P*) are all arranged in a symmetrical curve. *Ar 1*, first cervical arch with the atlas-axis articulation in front of it.



FIG. 11. Same patient as Figure 10. Roentgenogram made in extreme dorsal extension showing physiological constriction of foramina 3, 4 and 5.

spinous processes should be just visible at their tips behind the spine and the angle of the jaw usually crosses the second vertebra.

The articulation between the first and second bodies, extending transversely, is seen just above the second foramen. It is not abnormal for the edges of the articular surfaces of this joint to be slightly out of alignment with each other.

The pedicles on the side opposite to the visualized foramina, that is, the side farthest from the film, appear as a curved line of small equidistant oval shadows one for each vertebral body. If correct technique has been used in making the roentgenogram, this line of pedicle shadows will intersect the shadows of the vertebral bodies near their anterior surfaces. The interpe-

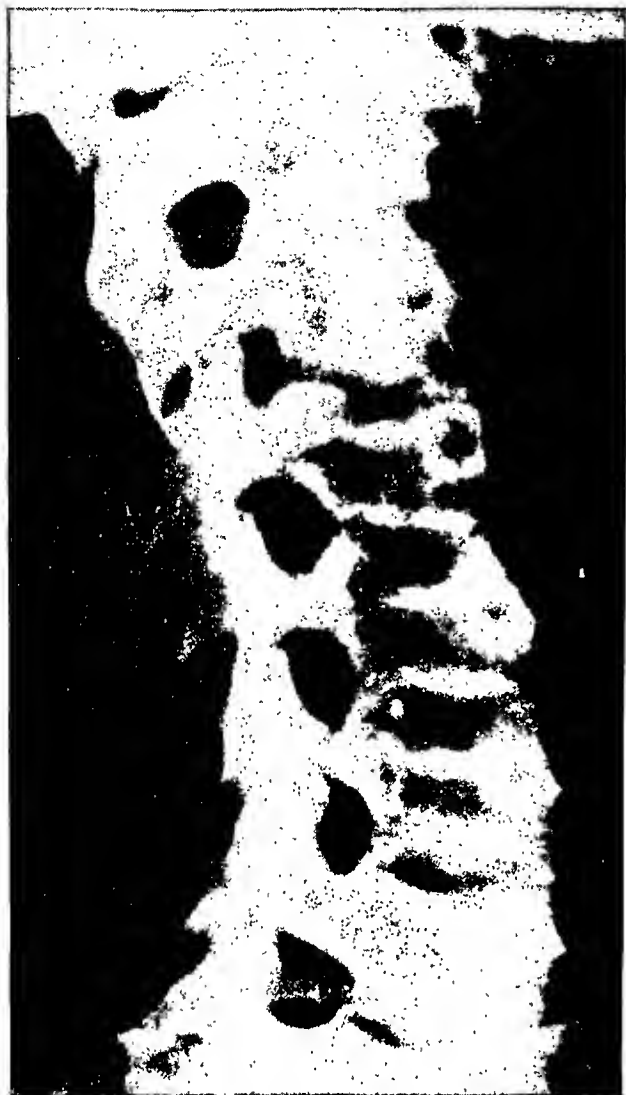


FIG. 12. Football injury—fracture of the sixth pedicle. Traumatic encroachment of third and sixth foramina.

diculate distance represents the size of the foramen. In certain cases of cervical spine disturbance, these pedicle shadows may be distorted in shape, size, spacing or alignment or in cases of advanced disc degeneration they may be obscured by demineralization and the overlying shadows of exostoses (Fig. 10).

#### DISC DEGENERATION (GEREDISC)

At the apices of the spinal curves, that is, the mid-cervical, mid-dorsal and lower lumbar region, the spine is placed under its greatest functional stress. It is likewise at these levels that the earliest, and later, the most advanced, stages of disc degeneration

occur—apparently as a direct result of the wear and tear of use. In the mid-cervical region this corresponds to the level of greatest amplitude of the gliding movement. At first, the changes are seen on the concave side of the curve, that is, the more compressed side of the disc. In the dorsal region this is anterior while in the cervical region the posterior portion of the disc first shows degenerative change.

This begins as a replacement of the nucleus pulposus by fibrous tissue. The cartilage plates of the disc become fragmented and loops of blood vessels grow through these openings from the vertebral bodies into the disc substance. Later the discs become thinned. Bony trabeculae may form from this fibrosis either entirely within the disc or projecting from the vertebral body into it (Fig. 8).

With thinning of the discs the margins of the vertebral bodies approach each other and bony spur formation or bridging is stimulated.

On section, two types of bridging are noted. More commonly one sees the "parrot beak" type wherein no matter how large the bridge becomes complete bony union never occurs. The two spurs are always separated by a layer of fibrous tissue extending outward from the disc. The other, solid type, appears as though molten bone had been poured from one vertebral body down across the edge of the intact disc margin to join the vertebral body below. It is very common for a separate bony fragment to develop in the margin of a disc and simulate fracture of an exostosis when no fracture has occurred.

Degeneration is not primarily the result of an infection or inflammatory process. Early disc degeneration will not show on the roentgenogram but when it has become sufficiently advanced it is seen as a thinning of the disc shadow with sclerosis of the vertebral plate, bony spur formation and bridging.

The word "geredisc," to indicate the aging process by which it develops, is a better term than "degeneration" to describe

this common condition resulting from the natural wear of life.

#### ARTHRITIS

The acute stage of this condition may involve even a single posterior articulation in the cervical region with limitation of motion and pain. The sharpness of the roentgen image is blurred and a well delineated joint shadow is not seen. Care must be taken to compare this joint with those above and below, bearing in mind any variation in the direction of their planes which may be present. With recovery, the normal sharpness of the roentgen image may return.

A chronic arthritis, or perhaps more properly arthrosis, may involve one or more of the posterior joints. The joint space is thinned, moth-eaten, or irregular in outline and there is sclerosis of the adjacent bony

tissue. Bony spur formation about the joint margins may project backward, laterally or forward into the foramen. It may be possible to demonstrate localized fixation of movement by the flexion-extension studies.

#### SPONDYLITIS DEFORMANS

In the late Marie-Strümpell type of spondylosis the anterior longitudinal ligament in the neck is seen as a delicately calcified structure, not the massive heavy bony bridging noted in the lower spine. Both the discs and the vertebral bodies preserve their normal cephalocaudad diameters. The posterior articulations are ankylosed and the normal size and shape of the intervertebral foramina are preserved. It is particularly interesting to note, however, upon study of the flexion-extension roentgenograms, that motion is preserved in the atlanto-occipital and the atlanto-axial joints

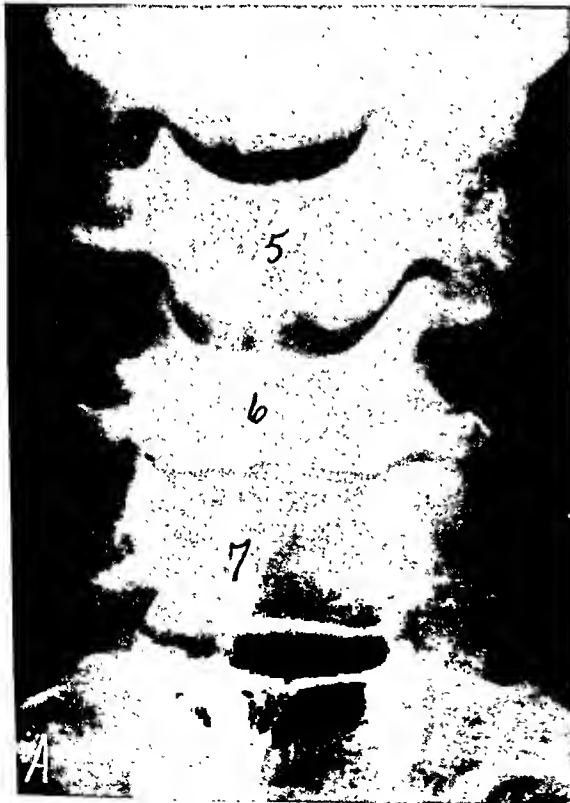


FIG. 13. Large spurs projecting from the left sides of the sixth and seventh cervical bodies encroaching upon the corresponding foramina. Other foramina normal.





FIG. 14. Roentgenogram of a cadaver specimen and sections cut from the foramina as indicated by the white lines. Top and bottom foramina normal showing the sectioned nerve root occupying about one-fifth the foramen diameter. The two middle foramina are encroached upon by bony exostoses from the vertebral discs.

where no intervertebral discs participate. Since diarthrodial joints away from the spine are little affected, the question arises as to whether or not this disease may not primarily involve the discs rather than the posterior articulations with secondary ankylosis of the latter (Fig. 9). Spontaneous forward subluxation of the atlas on the axis may take place in this condition.

#### FORAMEN ENCROACHMENT

There are at least six ways in which intervertebral foramen encroachment may occur.

The first is physiological. The foramen is constricted by dorsal extension (Fig. 11) or

by a permanent lordosis increasing the normal cervical curve and causing the superior articular processes to extend into the upper portion of the foramen. Dorsal kyphosis exaggerates the cervical curve. Rotation or flexion toward the foramen also decreases its diameter and the opposite movements enlarge the foramen diameter.

Trauma, as in fracture (Fig. 12), or rarely posterior displacement of a cervical body (Fig. 1) may constrict a foramen. Most displacements, however, are forward and these tend to enlarge the foramen.

As stated above, an arthritic process involving the posterior joint with bony exostoses projecting forward may cause foramen encroachment just as the bony spurs from the margin of a geredisc in front may project backward into the foramen (Fig. 7B). The spurs are much more extensive than they appear on the roentgenogram (Fig. 13).



FIG. 15. Increased anteroposterior diameter of cervical canal by pressure of neurofibroma. Cortex distortion at arrow.

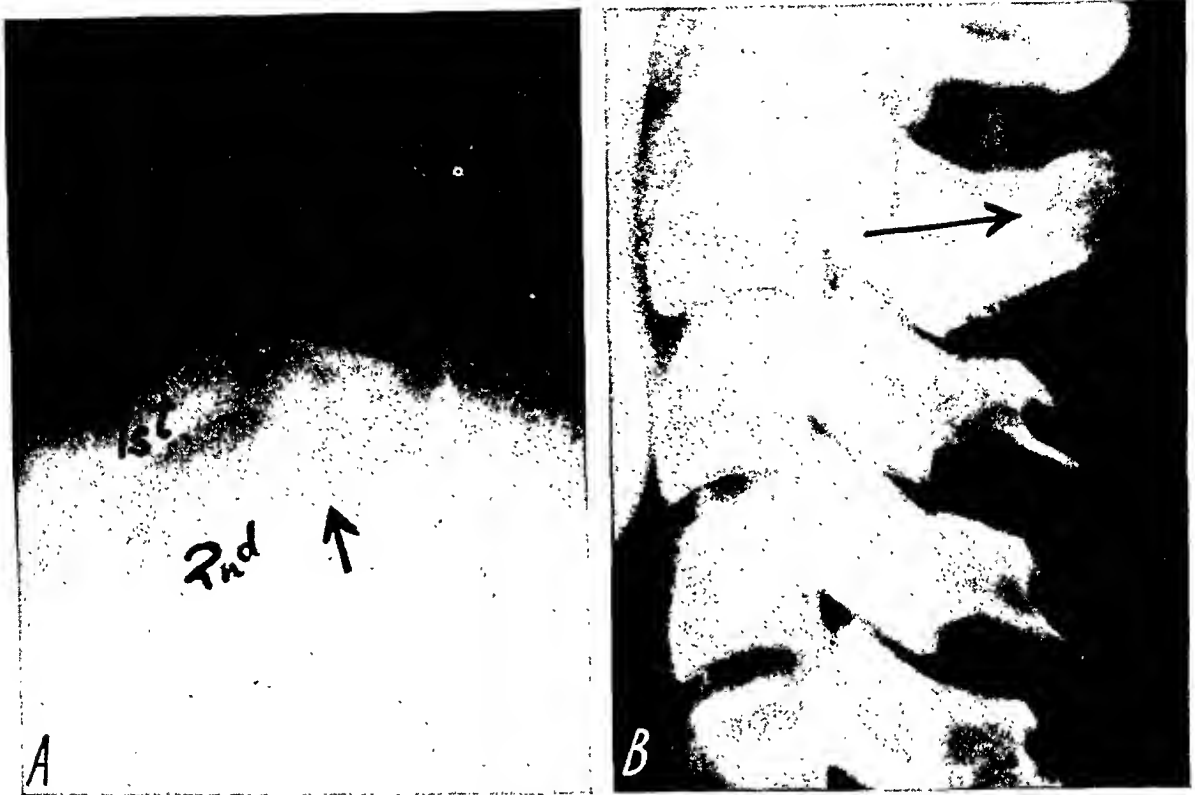


FIG. 16. *A*, first and second cervical arches seen through the foramen magnum. There is incomplete fusion of the second arch (arrow). *B*, lateral view, the cortex of anterior surfaces of arches (posterior wall of spinal canal) is normal for the 1st, 3rd, 4th, and 5th but is broken (saw-tooth shaped) for the 2nd arch, denoting incomplete fusion in the lateral view (arrow).

As I have previously described in connection with studies of the lumbar spine, thinning of the intervertebral disc from degeneration allows the bodies to come more closely together, producing not only encroachment of the foramen in a cephalocaudal direction but also a certain degree of posterior joint subluxation. The inclination of the planes of the posterior articulations in the cervical region accordingly induces wedging of the superior articular processes forward into the upper portion of the foramina. This joint derangement may be a partial factor in causing the local pain, muscle spasm, and limitation of motion of which these patients complain.

Fibrous hyperplasia of the posterior joint capsule is a factor producing constriction of the foramen in some cases. Also in many of the sections studied intervertebral disc substance is clearly demonstrated bulging backward into the foramen.

Normally the nerve occupies about one-

fifth to one-fourth the diameter of the cervical foramina; the remainder of the space is taken up by lymphatics, blood vessels, areolar and fatty tissue.

Bony or fibrous tissue encroachment may reduce the size of the foramen to one-fourth normal (Fig. 14), crowding the nerve into the lower portion of the opening or it may become flattened in a ribbon-like manner or even completely destroyed. In examining cadaver material the nerve can usually be separated within the foramen by blunt dissection. In other cases it appears to be adherent and surrounded by fibrosis.

Patients with foramen encroachment not only complain of local pain, tenderness, muscle spasm, and limitation of neck motion, but also frequently suffer from radiculitis. In the cervical region this condition is characterized by pain referred to the shoulder, arm or hand, corresponding in distribution to that of the involved nerve root and is frequently aggravated by cough-

ing or sneezing—the so-called Dejerine sign. Not all patients, however, suffering from radiculitis exhibit foramen encroachment on the roentgenogram.

#### PROFILE OF THE VERTEBRAL CORTEX

In the anteroposterior, lateral, and ob-

A familiar example is the circular shadows of the pedicles as visualized on the anteroposterior views of the dorsal and lumbar regions and the 45° oblique studies of the cervical region. It should be borne in mind that the interpediculate distance corresponds to the cephalocaudad diameter of

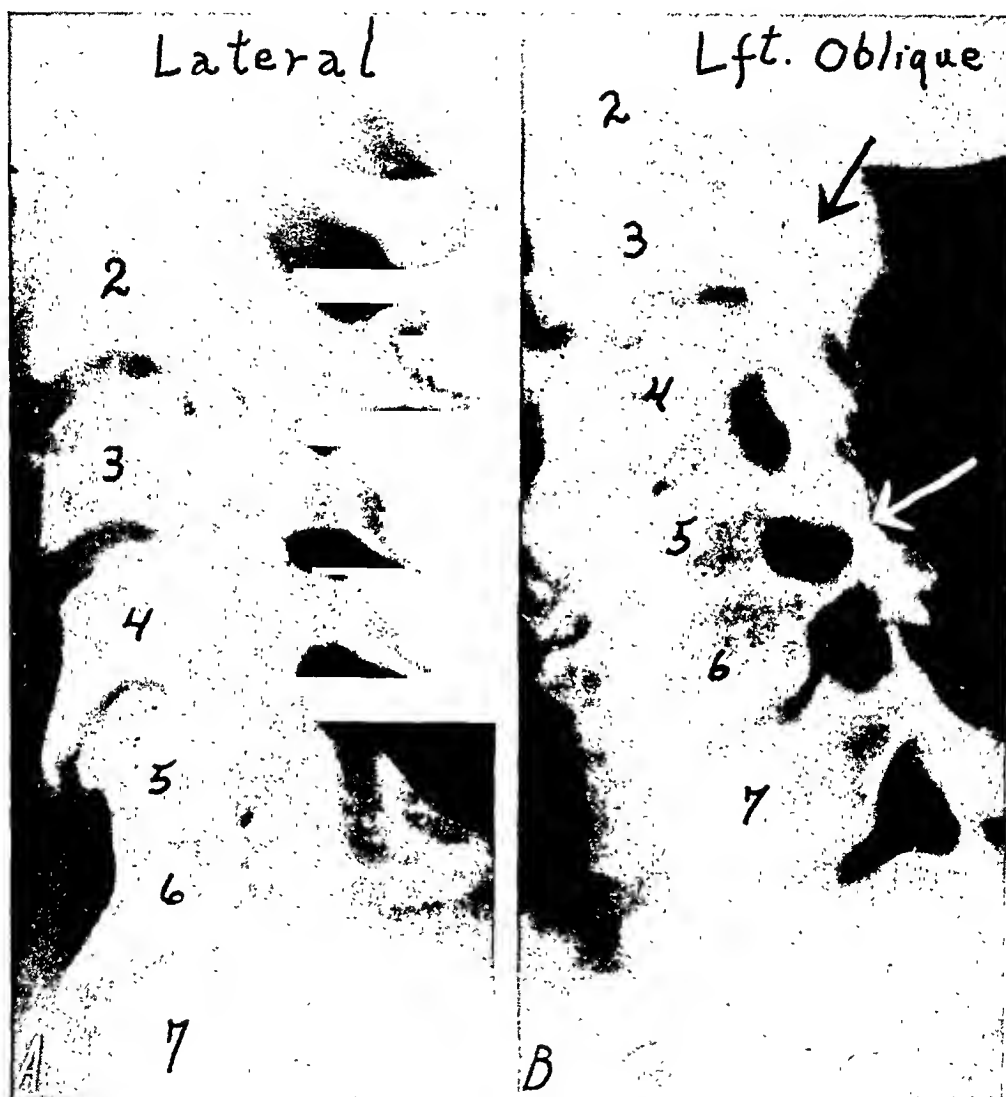


FIG. 17. Congenital fusion of fifth and sixth bodies, arches and posterior joints with one spinous process. Fifth foramen not constricted (white arrow). Increased stress on fourth and sixth discs with degeneration and spur formation but little foramen encroachment. Advanced arthritis (black arrow) of third left posterior articulation with bony encroachment of third foramen. Patient complained of local and radicular pain of many years' duration.

lique views, the cortex of bony structures when lying parallel to the ray appears as a dense white shadow—the profile of the cortex. A complete evaluation of these shadows adds much to the interpretation of the roentgenogram in three dimensions.

the foramen. Demonstration of a constricted foramen is easy even in this view when it is compared with the greater interpediculate diameter of the normal foramina. In tumors of the cord one is accustomed to seek some evidence of distortion of the



cortex on the medial side of the pedicle or the posterior surface of the vertebral body (Fig. 15).

In the oblique view of the normal cervical spine, the separate laminae appear as

the curve, project forward at a different angle (Fig. 7, *A* and *B*).

Not infrequently a fusion of adjacent laminae is encountered. In this case two or more of the smaller normal size oval shad-

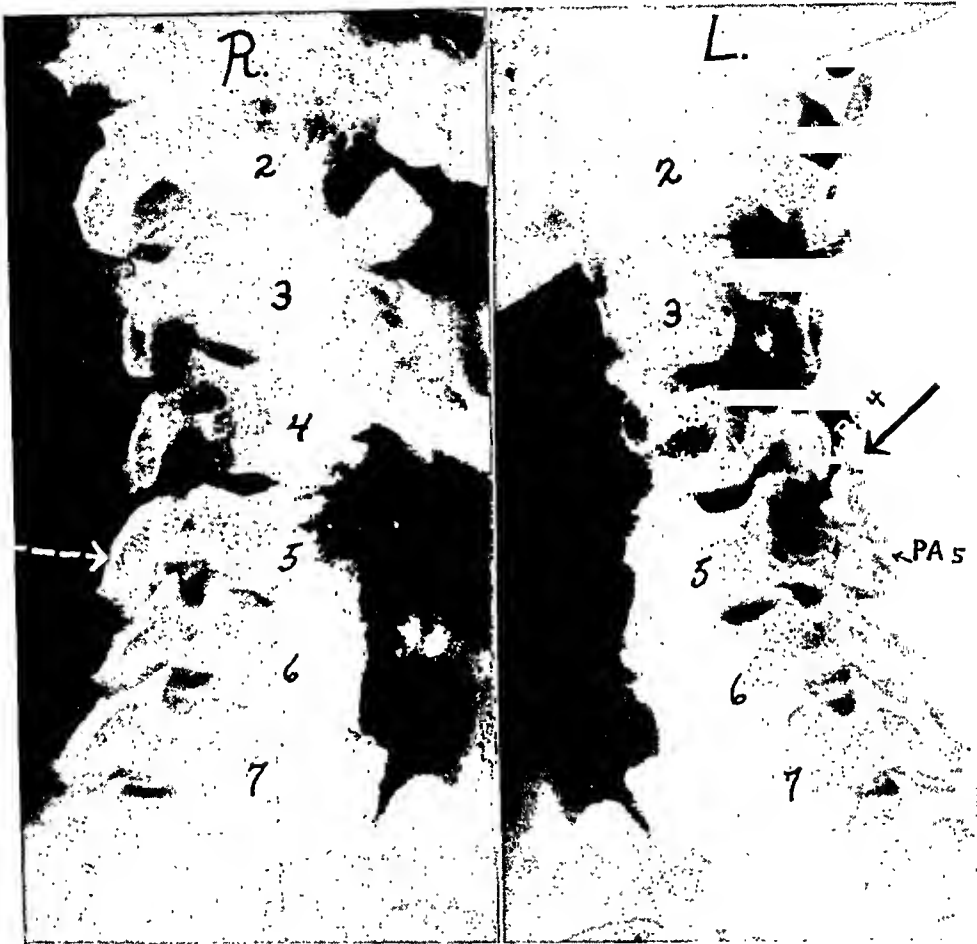


FIG. 18. Congenital absence of the fifth left pedicle. All pedicles on the right side are normal. On the left the fourth is small and the fifth is absent. There is a large common foramen for the left fourth and fifth roots. The shadow crossing this large foramen is the fifth transverse process. The unbalanced stress is partly borne by the fifth neural arch which has become more dense than normal (dotted arrow) and partly by a bony process projecting from the fifth body laterally and upward to the fourth. There is a break in the normal symmetrical curve of the posterior arches on the left side (white arrow). The left 4-5 posterior articulation (*PA4*) is deficient, the lower element being posterior to the upper and the 5-6 articulation (*PA5*) is above and posterior to its normal position. The triangular bone between *PA4* and *PA5* is the fifth neural arch. No history of injury in early life.

a series of dense, somewhat flattened oval shadows arranged in a symmetrical curve. If there is an angulation of the spine the distance between the oval shadows at the level of angulation is increased, the symmetry of the curve is lost at this point and those laminae above, instead of continuing

ows will be replaced by a large one—the profile of the cortex of the fused laminar mass (Fig. 23).

With demineralization from disuse or other causes, the cortex profile is proportionally not well visualized.

In the lateral view the dorsal surface of



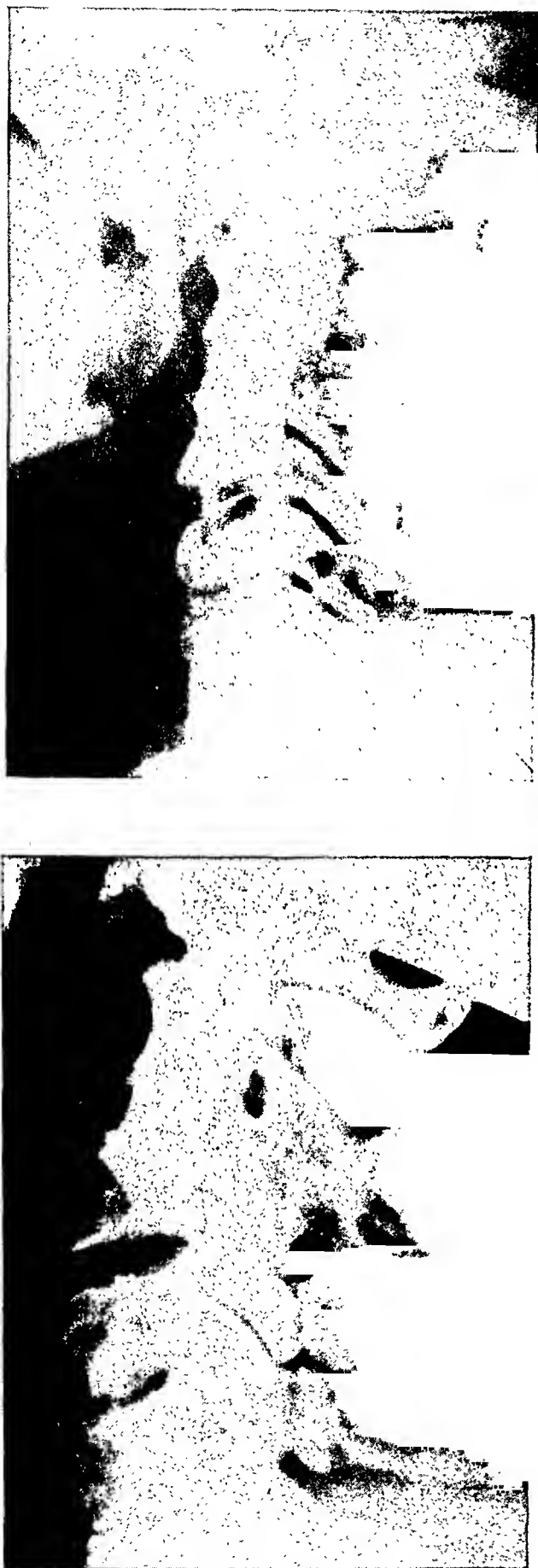


FIG. 19. Klippel-Feil syndrome. J. H., aged eight years, fusion second, third, and fourth bodies with their posterior articulations and arches, one spinous process. Fifth and sixth vertebrae separate.

the spinal canal, that is the anterior surface of the arch, appears as a very dense narrow white line. In case there is a spina bifida present it can be diagnosed from the lateral view since the dense white line above mentioned becomes irregular, broken, or disappears entirely (Fig. 16).

Further applications in a study of the



FIG. 21. J. H. Block vertebra higher on left side to compensate for tilt of neck to left caused by high right shoulder.

profile of the cortex will readily present themselves.

#### CONGENITAL CONDITIONS

One of the most common congenital conditions occurring at any level below the first segment is a fusion of two or more adjacent cervical vertebral bodies normally separated by discs. The disc is absent or indicated by a line of increased density. The arches may be separate with fusion of the

FIG. 20. J. H., aged twenty-two years. More complete fusion after fourteen year interval. Normal movement between occiput and atlas and between atlas and axis.

posterior joints or they may be united into one bony mass with a single large spinous process.

The bony mass is likely to be higher on one side than on the other if necessary to compensate for a lateral tilt to the cervical spine (Fig. 21). The foramina at the site of congenital fusion are always smooth and round while in cases of acquired fusion resulting either from injury or from degeneration of the disc there is usually a distortion in the shape of the foramina.

This condition is easily differentiated from spondylosis deformans where union of vertebral bodies occurs by bridging of the persistent disc and ankylosis of the posterior joints (Fig. 8).

Functionally this condition forms a point of non-movement in the otherwise symmetrical flexion of the neck, placing addi-

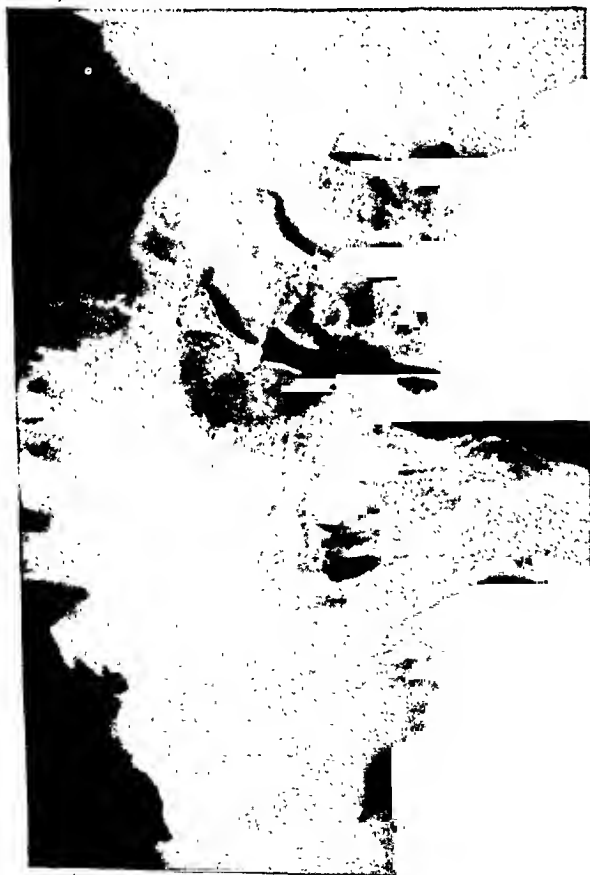


FIG. 22. J. H. Fusion of lower cervical and upper dorsal elements with scoliosis and spina bifida (dotted line).



FIG. 23. J. H. Right oblique view showing smooth round foramina of fused elements (black arrows)—foramina at movable level (dotted black arrow). Note difference in shape of normal foramina from those with congenital fusion. Profile of cortex of fused laminae (white arrows), the lower one incorporating at least four segments. White dotted arrow indicates foramen for the vertebral artery.

tional stress upon the adjacent movable joints and favoring their earlier degeneration (Fig. 17).

Certain structures, such as a pedicle or a posterior articulation, may be absent or deficient (Fig. 18).

#### KLIPPEL-FEIL SYNDROME

This more advanced congenital condition arising early in intrauterine life is caused by the fusion of various cervical segments. It



FIG. 24. C. C. Atlanto-occipital fusion in anterior flexion, no movement between occiput and atlas or between second and third fused vertebrae. Movement below this normal.

is characterized by short neck, low hair line, limited but painless movements of the neck, and rounded back. The patient may have prominent trapezius muscles, the "webbed" neck or pterygium colli. The scapulae may be raised (Sprengel's deformity) and the nipples low. Various other findings sometimes present are: depression in the midline posteriorly, torticollis, mirror writing, anterior or posterior spina bifida, scoliosis, and cervical ribs. Study of the profile of the vertebral cortex is instructive.

The fused elements unite into a solid block often with a single large spinous process, neural arch, and vertebral body but no posterior articulations. The interverte-

bral foramina persist but are smaller than normal and smooth and round or oval in outline. There is one for each of the segments making up the block and each is a complete bony ring unbroken by disc or posterior articulation. There may be one or more normal cervical segments, hemi-vertebrae, cervical ribs or an atlanto-occipital fusion (Fig. 19-23).

#### ATLANTO-OCCIPITAL FUSION

The occiput is said to represent a fusion of at least three cervical segments and, since any level of the spine may at times assume the characteristics of that level immediately above or below it, one of these segments may partly assume the vertebral form, or a complete or partial fusion of the atlas and occiput may take place. On one of the specimens in the Warren Museum at Boston, it is possible to clearly differentiate on the inside of the skull the outlines of the atlas forming a part of the occipital bone.

The ring of the atlas may or may not be incomplete posteriorly. It may be fused to the occiput on one or both sides. Flexion-extension studies will show that it does not separate from the base of the skull upon extreme forward flexion. Fusion of two or more cervical segments is likely to be present. Flattening of this area is spoken of as a platybasia (Fig. 24-26).

#### BASILAR IMPRESSION-(INVAGINATION)-PLATYBASIA

At least two distinct types of this condition can be differentiated. First, the congenital type with atlanto-occipital fusion, flattening of the occipital bone, distortion in the shape of the foramen magnum and displacement of the odontoid process upward into this structure decreasing its anteroposterior diameter.

The acquired type is secondary to a softening of the base of the skull as in Paget's disease, osteomalacia, or hyperparathyroidism. The skull is invaginated by the cervical spine like a thumb pressing against a soft rubber ball, thrusting the base upward into the posterior fossa. In this type, the

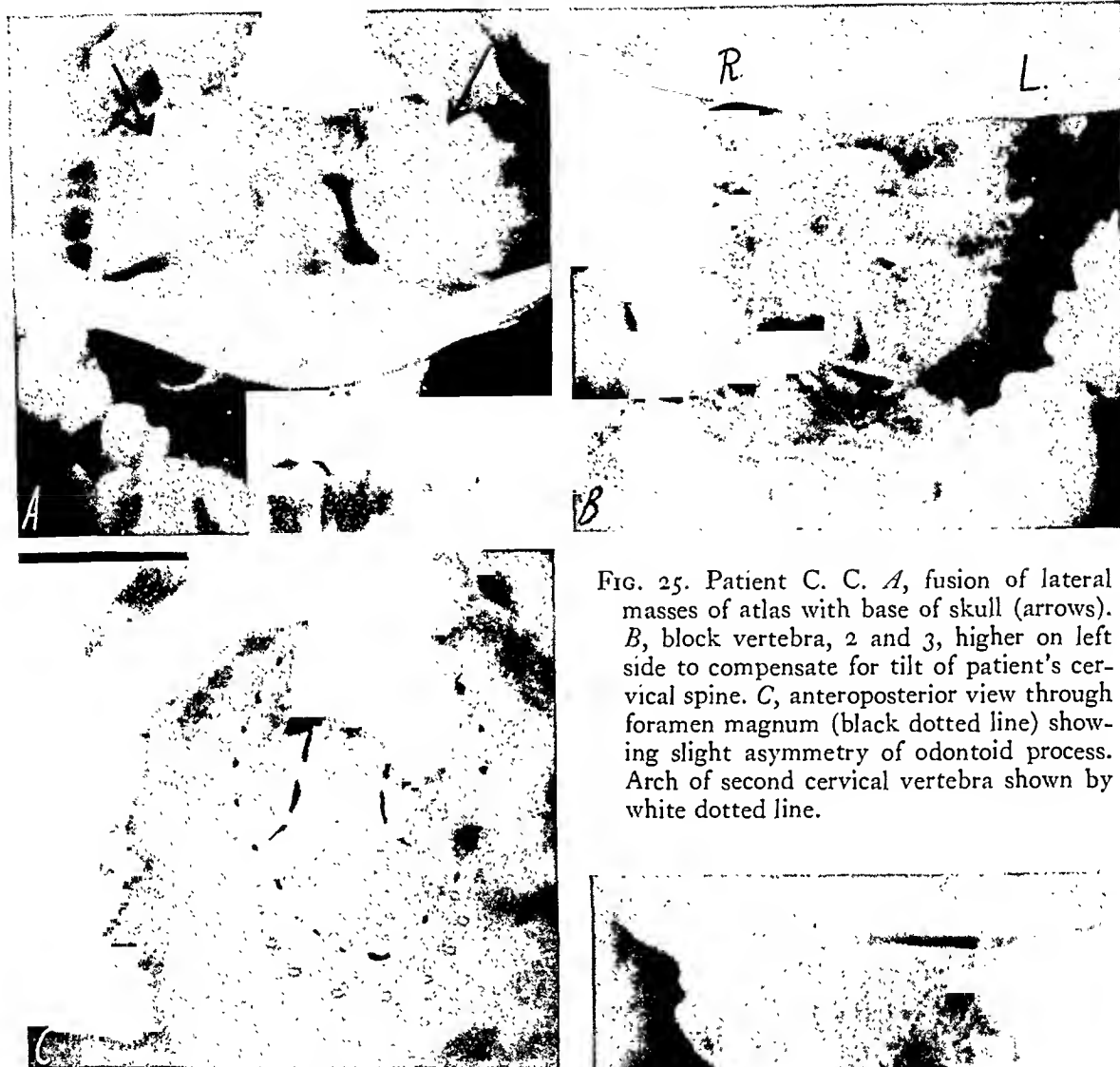


FIG. 25. Patient C. C. *A*, fusion of lateral masses of atlas with base of skull (arrows). *B*, block vertebra, 2 and 3, higher on left side to compensate for tilt of patient's cervical spine. *C*, anteroposterior view through foramen magnum (black dotted line) showing slight asymmetry of odontoid process. Arch of second cervical vertebra shown by white dotted line.

basilar portion of the skull is convex upward showing as a reverse curve. The foramen magnum may be as high as the petrous pyramids and funnel shaped, but it is not distorted in outline and the odontoid is anterior to it. The base may develop a recess to accommodate the atlas but the latter does not fuse with the occiput. Flexion-extension studies reveal movement between the base of the skull and the atlas.

Common to both types is the high position of the first cervical segment above the line from the hard palate to the posterior

FIG. 26. C. C. Oblique view showing normal foramina in a case of congenital type of platybasia. Second and third bodies fused.





FIG. 27. Basilar impression, invagination of the base indicated by dotted line convex upward instead of downward. Notch in base to accommodate first arch (white arrow), atlanto-occipital joint movable (black arrow). First segment appears above Chamberlain line. This is a case of acquired platybasia due to softening of the base incidental to Paget's disease.

margin of the foramen magnum described by Chamberlain. The petrous pyramids are raised above their normal position and dis-

torted in shape. The clivus is nearly on a plane with the floor of the anterior fossa. The neck is short, with lessened movement of the head which may be carried at an angle. There is likely to be exaggeration of the normal anterior cervical curve in which case the foramina will be smaller than normal.

The resulting compression of the cord or cranial nerves may simulate multiple sclerosis, syringomyelia, progressive spastic paralysis, or some other neurological condition. Compression of the cerebellum may force a part of its substance to herniate downward into the cervical canal, the so-called Arnold-Chiari malformation. Authorities agree that operation is indicated in certain cases, and if undertaken, the dura must always be opened (Fig. 27 and 28).

#### OCCIPITAL VERTEBRA

This condition results from incomplete assimilation of the most posterior of the three scleromeres which form the base of the skull. That is, the area about the foramen magnum assumes certain features re-

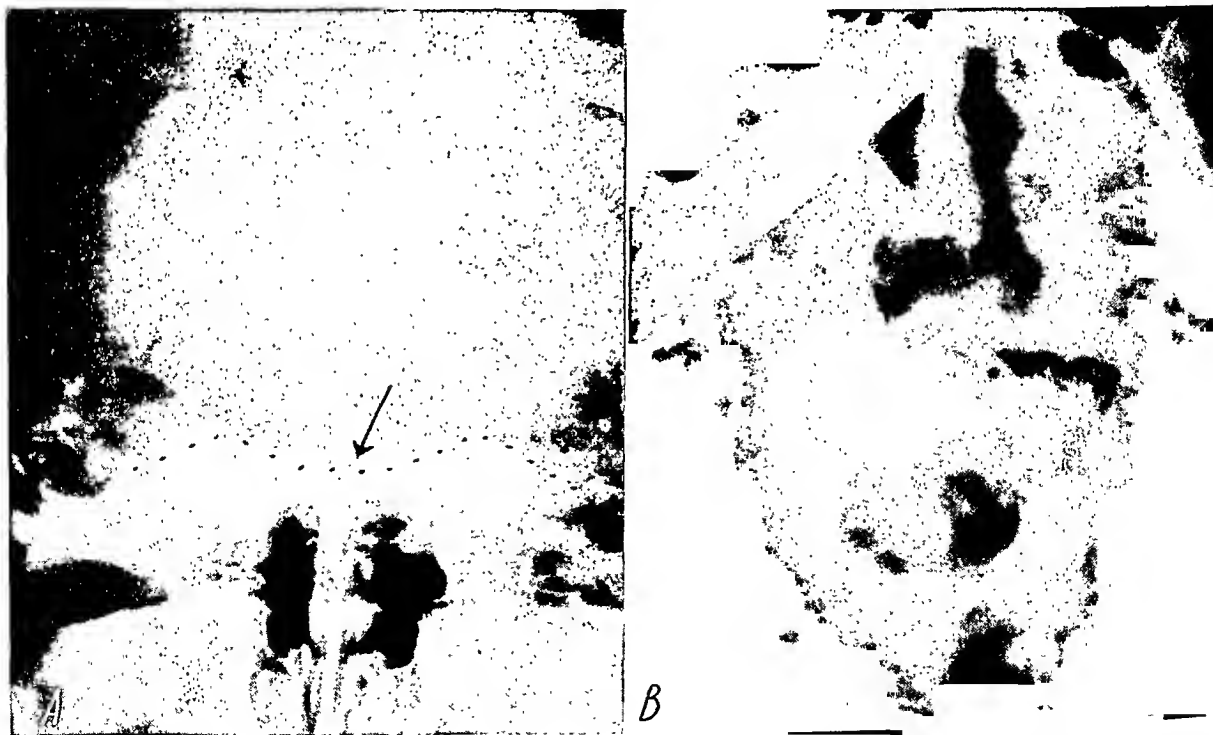


FIG. 28. *A*, anteroposterior view showing base, convex upward (dotted line) with funnel-like crater of foramen magnum in the center (arrow). *B*, symmetrical foramen magnum with odontoid anterior to it, no foramen encroachment.

sembling a vertebral segment. These are: (1) A hypochordal arch, partially or completely fused to the anterior margin of the foramen magnum. Rarely this bears an articular surface for the third condyle (see below). (2) A partial or complete neural arch outlined about the dorsal surface of the foramen. (3) Transverse processes may or may not be present, more or less fused to the base of the skull. If present they do not bear a foramen for the vertebral artery. (4) These masses, bearing the condyles, may or may not encroach upon the foramen distorting its shape. (5) The condyles resemble those of the normal subject. (6) The so-called third condyle may be present in the anterior portion of the foramen. This is a separate ossicle developed from the notochord in the terminal ligament of the odontoid and may embryologically in the normal subject form the tip of that structure. Analogous to the relationship between the atlas and the dens the third condyle corre-



FIG. 30. Anterior flexion. Comparing with Figure 28, note movement between atlas and occiput. These flexion-extension studies, Figures 28 and 29, illustrate: (a) the normal gliding movement of the cervical bodies backward and forward upon each other, and (b) the approximation and separation of the spinous processes.



FIG. 29. Posterior extension. Note ledge of bone projecting downward and forward from occiput. The print is too light to show the shortened odontoid.

sponds to the body of the occipital vertebra with the hypochordal arch in front and the neural arch behind. Occipital vertebra is to be differentiated from atlanto-occipital fusion.

An eleven year old female suffering from occipital vertebra showed the following neurological symptoms:

Temperature and tactile perception were normal on the right side of the body. On the left side, however, there was hypesthesia to tactile and pain stimuli, and heat perception was lost while cold was interpreted as a painful sensation of heat. Tendon reflexes were exaggerated on the right side and normal on the left. Abdominal reflexes were present on the right and absent on the left. There was a strong Babinski reflex and some disturbance of coordination.

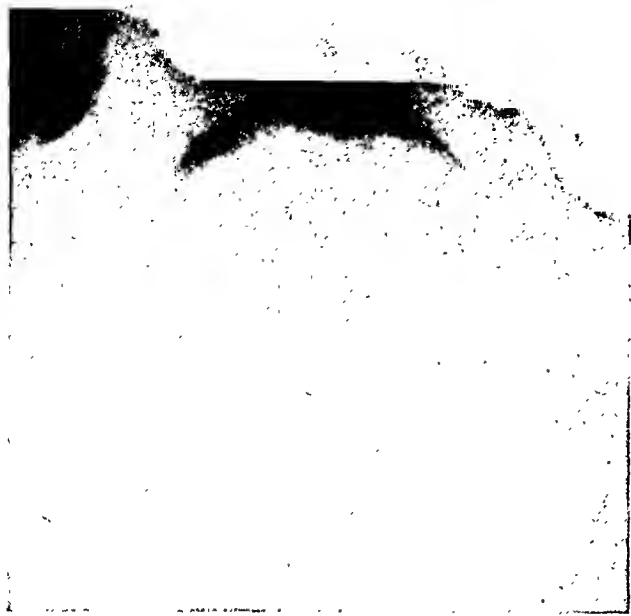


FIG. 31. Posteroanterior view of foramen magnum, shaped like a bicycle seat. The posterior, wider portion above crossed by the arch of the atlas and the anterior portion below encroached from the sides by masses of bone. The tip of the third condyle is just visible at the bottom of the narrowed anterior portion of the foramen.

In this case the roentgenograms showed:  
1. A normal atlas.



FIG. 32. Showing the "third condyle"—ossiculum terminale; anteroposterior view through the mouth: CI, two upper central incisor teeth; TC, a completely separate ossicle the so-called "third condyle"; O is the short stubbed odontoid process separate from the ossicle; 1, 2, and 3 indicate the respective cervical arches.

2. A broad, short odontoid process.

3. The posterior margin of the foramen magnum was thinned and below normal level. At operation this was found to bear, somewhat laterally, 2 cornua—the rudimentary, incomplete neural arch.

4. The outline of the foramen magnum seen above the level of the atlas was shaped like a bicycle seat. This was caused by two bony masses projecting from the sides of the foramen and encroaching upon its anterior portion.

5. Within this narrowed portion was a distinct oval-shaped ossicle entirely separate from the odontoid.

The importance of this congenital condition and its place with the platybasias in surgical treatment is shown by the operative finding in this case of a constriction of the dura at the level of the foramen magnum (Fig. 29-32).

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Acknowledgment is made of the assistance in this study by the Departments of Anatomy and Pathology of the Syracuse University College of Medicine.

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# THE EFFECT OF INCREASED INTRASPINAL PRESSURE ON THE MOVEMENT OF IODIZED OIL WITHIN THE SPINAL CANAL\*

By BERNARD S. EPSTEIN, M.D.

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**D**URING roentgenoscopy in the course of iodized oil myelography definite upward movement of the column of oil was observed when the patient coughed. He was asked to cough again and the observation was confirmed. From that starting point 20 consecutive patients who were examined roentgenoscopically as part of their myelographic studies were checked for the effect on the oil column of forced respiration, increased intra-abdominal pressure, liver pressure and coughing.

All the patients had been referred for oil myelography as part of the investigation

for herniated nucleus pulposus. The roentgen examinations were made on a motor driven tilt table equipped for spot film roentgenography. Three cubic centimeters of pantopaque\* were injected intraspinally, affording a column of oil ample for diagnostic purposes. Lipiodol was used in 2 patients with identical results. The roentgenograms were made with the patient face

\* Pantopaque is ethyl iodophenylundecylate, prepared and distributed by the Department of Radiology, School of Medicine and Dentistry of the University of Rochester, Rochester, N. Y. Supply limited by Federal law to investigational use only, and supplied to Dr. L. M. Davidoff through the courtesy of Dr. Stafford Warren.

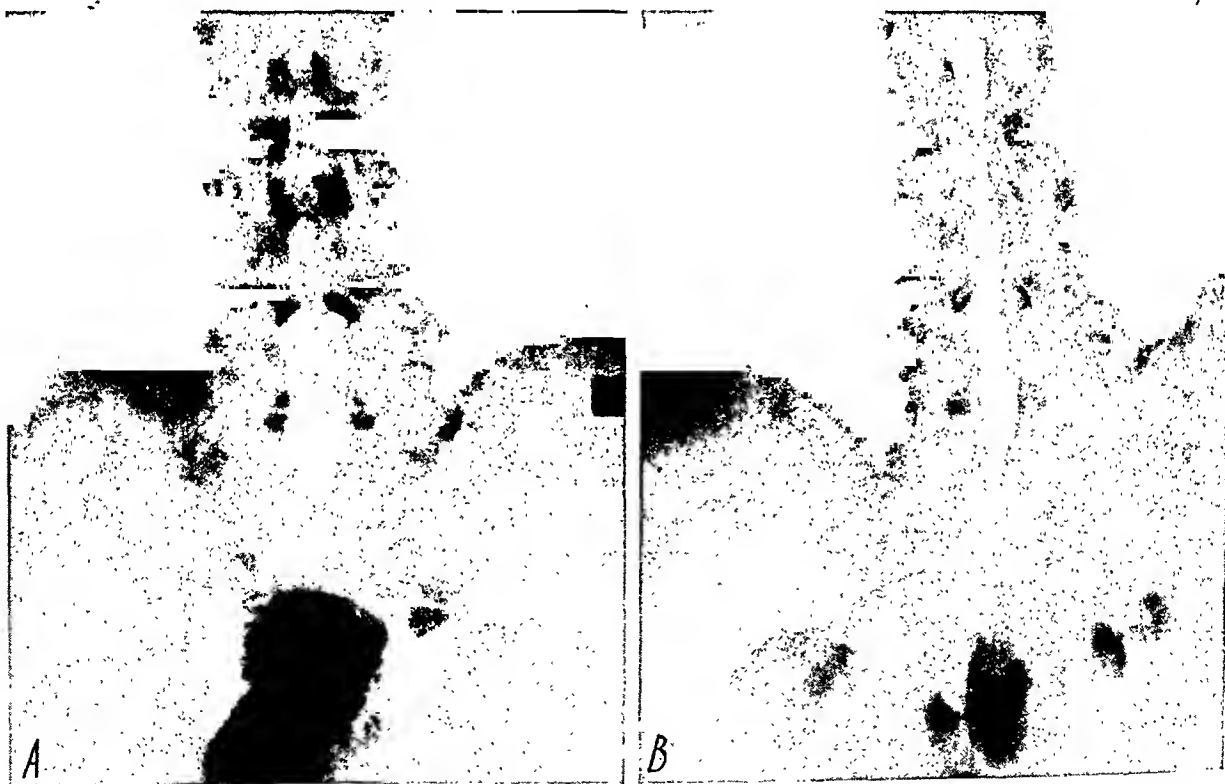


FIG. 1. *A*, column of iodized oil with patient in the erect position. Normal myelogram, with axillary pouches poorly visualized. *B*, roentgenogram taken while patient was straining as if at stool. The oil column has risen 8 cm., thinning out the density and revealing the axillary pouches of the second, third and fourth lumbar roots. Those of the fifth are better seen on the original myelogram.

\* From the Radiologic Service of Dr. M. G. Wasch, and the Neurosurgical Service of Dr. L. M. Davidoff.

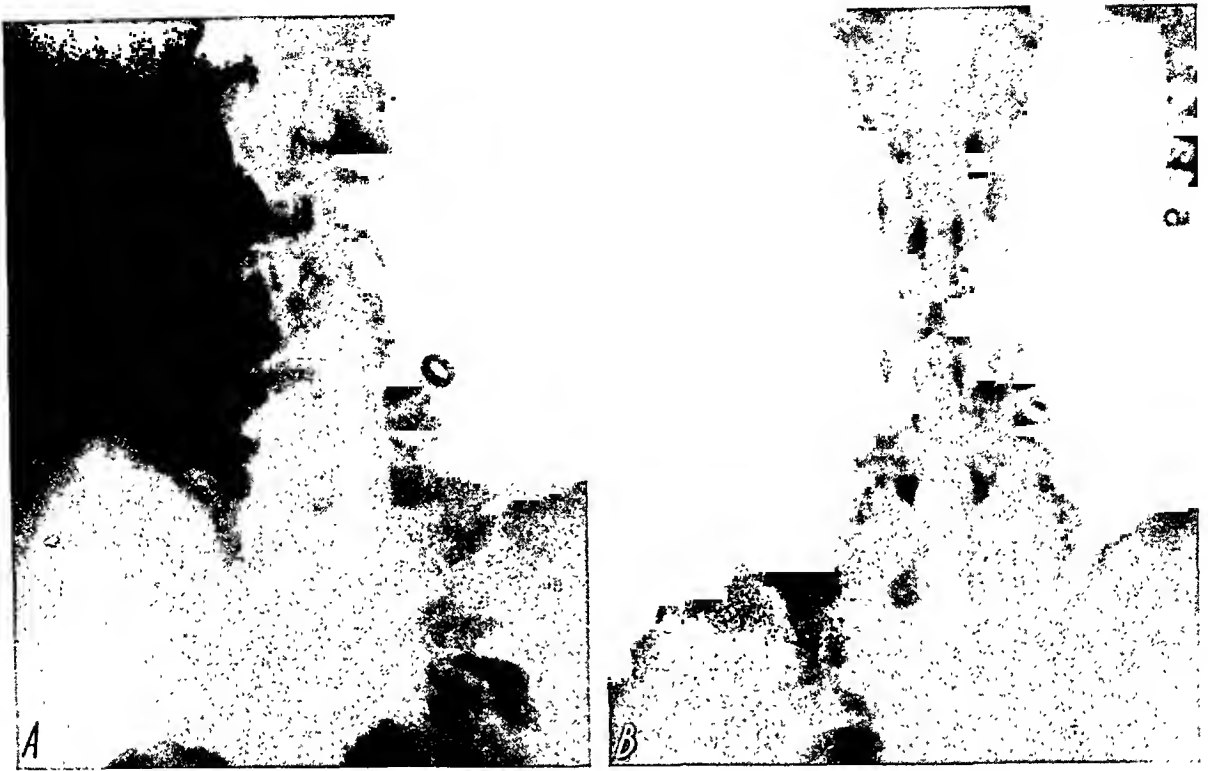


FIG. 2. *A*, same case as in Figure 1, with the patient in the supine position. *B*, myelogram taken at the height of straining. The oil column has risen more than 10 cm., and the axillary pouches are well portrayed. Note the change in density of the oil column.

down in the erect and horizontal positions after the location of the suspected pathological condition had been determined roentgenoscopically. It was thought best to obtain at least three exposures in each position with the patient at rest. Additional roentgenograms were made during the brief interval in which the patient was told to cough deeply or "strain as if you were moving your bowels."

In 18 patients straining as if at stool, forced respiration or coughing resulted in an upward excursion of the oil column within the spinal canal. The greatest rise occurred in the most cooperative patients. With the patient in the erect position the oil column rose from 3 to 7 cm., and in the prone position the ascent was greater, reaching up to 10 cm. We believe that the 2 patients who had no demonstrable response did not understand directions despite efforts to make their meaning clear.

The ascent of the oil column was usually rapid, reaching its maximum a few seconds

after the increase in intra-abdominal pressure was started. The greatest response was elicited when the patient strained as if at stool. When pressure was relaxed the oil column rapidly resumed its resting position, requiring less time to recede than it did to rise. The movement may aptly be described as a "jump." It was noteworthy that when intra-abdominal pressure was gradually increased the rise of the oil column was gradual, and when pressure was suddenly increased the elevation was more rapid. The descent was rapid, occurring as soon as the increased intra-abdominal pressure was relieved. However, by relieving pressure slightly and immediately thereafter increasing intra-abdominal pressure, the oil column could be forced as high as the lower thoracic vertebral level with the patient in the erect position in several instances.

As the oil column rose its shadow became thinned peripherally. This might conceivably obscure small lateral defects. The deformity of the axillary pouches, however,



FIG. 3. *A*, shallow lateral defect in oil column on left side, fifth interspace. *B*, myelogram taken at height of straining. The lateral defect is not seen as well as in *A*, but the elevation of the suprajacent axillary pouch is better visualized. The oil column has risen 6 cm. visualizing the middle lumbar region of the canal.

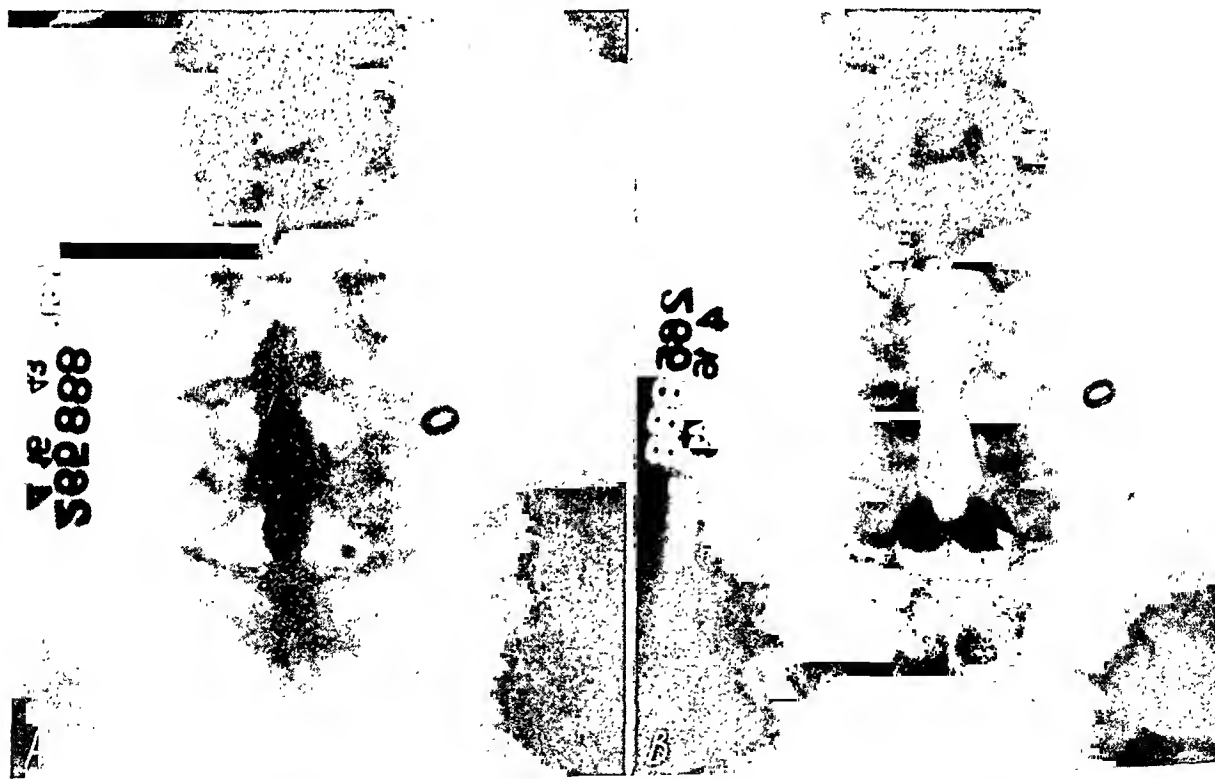


FIG. 4. *A*, myelogram taken with the patient in the erect position. The axillary pouches of the fifth lumbar segment are well portrayed. There is a suspicious thinning of the top of the oil column. *B*, myelogram taken in the erect position at the height of straining. A large defect is seen at the fourth lumbar interspace on the left side.

might be accentuated, thus avoiding diagnostic errors. Deeper lateral indentations occasionally are brought into bolder relief as the column thins out, and in these patients the axillary pouches also become more apparent. Transverse defects may be entirely hidden, the radiolucent shadow being replaced by a zone of oil less dense than that above and beneath the lesion.

The pouches in the segment above that under examination are often brought into view during strain, thereby adding to the completeness of the examination. Occasionally roentgenograms made with the patient at rest do not portray the axillary pouches adequately. These may be accentuated by requesting the patient to strain and taking the roentgenogram immediately after pressure is relaxed.

As the oil column thins out during the time a patient strains, it is possible that small projections not due to prolapsed discs may be outlined. We have not had the opportunity to observe such a patient thus far, and would recommend that this procedure be utilized when the opportunity arises.

Patients who had a sciatic distribution of pain complained of exacerbation of pain down the affected leg and occasionally the contralateral side during the time increased intra-abdominal pressure was maintained.

The pain was relieved as soon as straining ceased.

#### COMMENT

The only reference to this subject in the literature was made by Reitan<sup>1</sup> 1941. Our observations, which were made without knowledge of Reitan's work, completely confirm his observations. The movement of the oil in the canal is due, we agree, to an increase in the amount of blood in the vascular bed, especially in the venous plexus between the dura and the walls of the spinal column. As tension is increased the veins dilate, decreasing the available space. When this occurs the contents of the caudal end of the canal perforce must be thinned out, and in order to accommodate the constant volume of oil in the decreased available space the oil column rises.

Roentgenoscopic observation of the oil column affords a graphic illustration of the movement of fluids within the spinal canal. This maneuver is easily performed, and should be included in routine myelographic examinations.

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# OSTEIOD-OSTEOMA OF THE HEAD OF THE RADIUS

## CASE REPORT\*

By HERBERT M. STAUFFER, M.D.

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**O**STEIOD-OSTEOMA was described and named by Jaffe<sup>1</sup> in 1935. In a subsequent communication<sup>2</sup> he and Lichtenstein reported conclusions based on the study of a total of 33 cases. According to these authors, osteoid-osteoma is a benign neoplasm involving a single bone in the limbs or vertebral column of adolescents and young adults, and in their opinion the roentgenogram constitutes the most important diagnostic study. The lesion gives rise to persistent localized bone pain without local heat or febrile episodes. Surgical excision has been found curative.

Two aspects of the pathologic picture explain the roentgen appearance, which is so frequently characteristic. Initially a focus of osteoblasts proliferates and forms osteoid tissue. The adjacent bone undergoes a reactive sclerosis. Thus, the roentgenogram at this stage shows a well defined radiolucent spot, usually about 1 cm. in diameter, with a variable sized surrounding zone of osteosclerosis. As the osteoid focus calcifies, its definition becomes poorer and eventually this primary lesion may be indistinguishable in the roentgenogram. A cortical lesion may stimulate sclerosis above and below it for a considerable distance in the shaft. In contrast, where the spongiosa is primarily involved the abnormal density is apt to remain relatively small and circumscribed.

The roentgen findings have been misinterpreted as representing manifestations of chronic osteomyelitis, intracortical abscess, luetic osteitis, and even osteogenic sarcoma.

The case report which follows illustrates some of the diagnostic pitfalls which may be avoided if this entity is kept in mind.

### CASE REPORT

The patient, a white male, aged twenty-five,

was admitted to Temple University Hospital (November 10, 1939) on the service of Dr. John Royal Moore, complaining of intermittent pain in the right elbow of about two years' duration. Discomfort was mild initially and was unrelated to trauma. During the year preceding admission, the patient had been taking considerable amounts of aspirin for control of pain.

At another hospital, roentgenograms of the elbow had been interpreted as suggesting an old infectious process, with an early malignant lesion to be ruled out. The serology was negative and antiluetic therapy failed to affect the symptoms or the roentgen appearance. At the same institution, biopsy of the roughened surface of the proximal end of the right radius on February 13, 1939, yielded material that did not permit histopathologic identification of the lesion; no pus was encountered on drilling the bone. The pain persisted following fifteen roentgen treatments, administered between June 1, 1939 and July 5, 1939, to an anterior portal measuring 6 by 6 cm.; a total of 1,575 r was given (200 kv., 0.5 mm. Cu, 1.0 mm. Al).

*Physical Findings.* The proximal end of the radius was enlarged and the forearm in this region was tender. Supination, pronation and extension of the forearm were limited.

The clinical findings were considered suggestive of sarcoma involving the head of the radius.

*Roentgen Findings.* (Fig. 1.) Thickening and increased density of the proximal radial diaphysis extend distad about 3 cm. from a point just below the head of the bone. Adjacent to the articular surface there is a circumscribed, spherical, radiolucent area. The articular surface of the radius is intact and there is no abnormality otherwise of the elbow joint.

This appearance was interpreted as indicating chronic osteomyelitis—the radiolucent zone representing localized bone destruction.

*Pathological Findings.* (Report of Dr. Ernest E. Aegerter.) The proximal portion (5 cm.) of the right radius was resected by Dr. J. R. Moore.

*Gross Description:* (Fig. 2.) The specimen is the head of the right radius measuring 5 cm. in

\* From the Department of Radiology, Temple University Medical School and Hospital, Philadelphia.

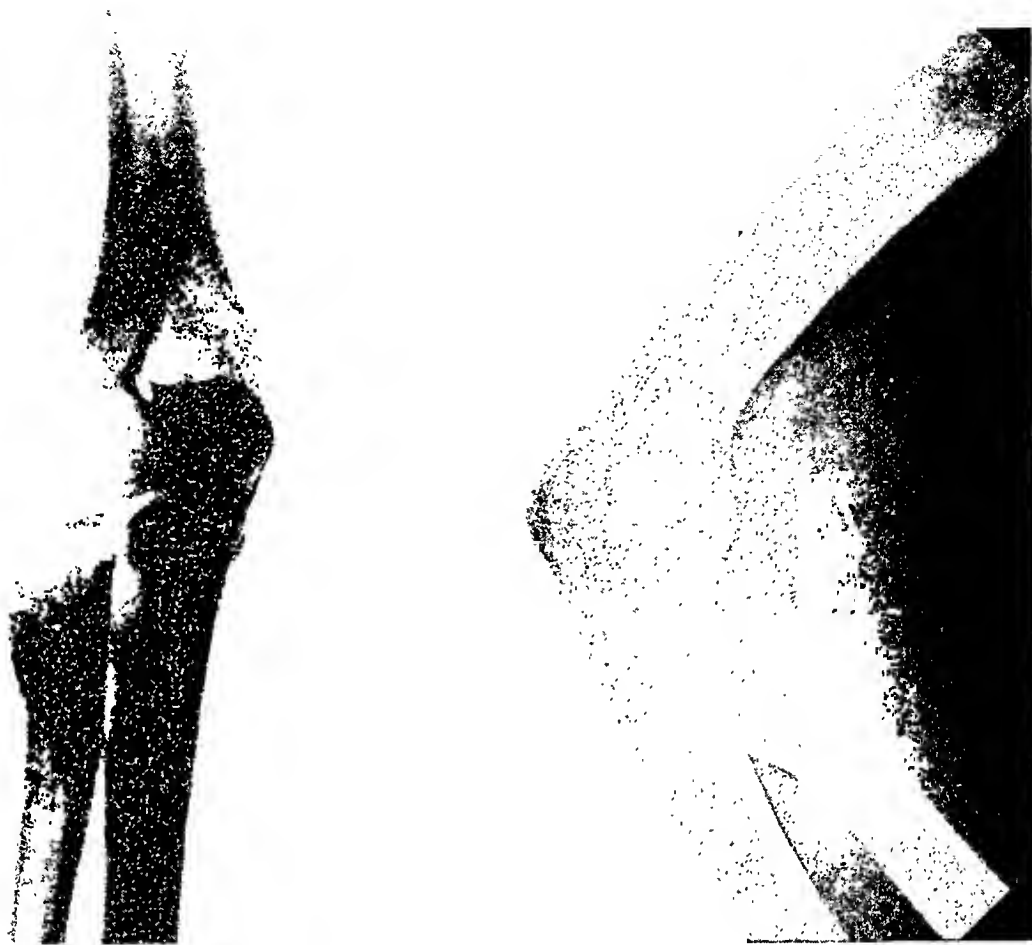


FIG. 1. Roentgenograms of right elbow.

length. The cartilaginous joint surface shows nothing of pathologic significance. In the epiphysis of the bone, directly below the joint surface cartilage, there is a spheroid mass measuring approximately 1.4 cm. in diameter. It is of a reddish brown color, somewhat pale in the center. It is sharply delineated from the surrounding bone tissue. Its consistency is rather soft, though palpation reveals the presence of gritty material, probably calcified bone spicules. There is roughening and thickening of the contiguous cortical tissue.

**Histopathologic Description:** (Fig. 3.) The central portion or nidus of this lesion is made up of irregular masses of calcified osteoid. This tissue is composed of coarse bundles among which are interspersed numerous large cells of varying size and shape. A lamellar pattern is lacking. These coarse, irregular masses are lined along their surfaces by a row of osteoblasts, and here and there are cells resembling osteoclasts. The ground substance consists of pleomorphic,

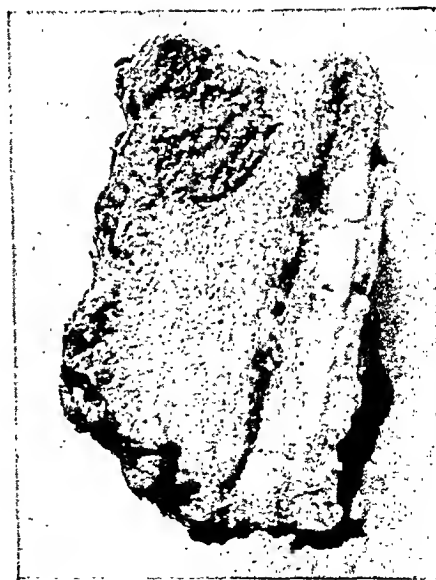


FIG. 2. Photograph of proximal end of radius, sectioned longitudinally.



FIG. 3. Low power (approximately  $\times 35$ ) photomicrograph showing osteoid focus.

spindle, collagen-producing cells. Giant cells are common throughout the lesion. The osteoid trabeculae in the outer zone show less calcium. In these regions there is the pigmentation of old hemorrhage. The tumor mass is sharply demarcated from the surrounding spongiosa. About its periphery the bone trabeculae are thickened and heavy. Osteoblasts are numerous on their surfaces and the intertrabecular tissue is quite densely fibrotic. There is no histological evidence of an infectious process.

The original pathological diagnosis was "healing benign giant-cell tumor." Review of the roentgenograms recently suggested osteoid-osteoma as a more likely possibility. The clinical, roentgenological and pathological features

of the case are all in keeping with the latter diagnosis.

Following operation the patient was relieved of pain and he has remained in good health.

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## MILITARY ROENTGENOLOGICAL TRAINING\*

By LIEUTENANT COLONEL HENRY G. MOEHRING

*Medical Corps, Army of the United States*

THE mission of the United States Army Medical Department is the conservation of man power—the preservation of the strength of the military forces. This is accomplished in several ways: (1) by selecting for and enrolling in the Armed Forces individuals physically fit for military service; (2) by maintaining these individuals in good physical condition, and (3) by furnishing evacuation, hospitalization and medical treatment to those who become disabled in order to restore them quickly to health and fighting efficiency.

Roentgenologists aid in accomplishing the Medical Department's mission. In the selection of personnel for the armed forces, standard roentgen diagnostic procedures are utilized in evaluating the individual's physical fitness; roentgen examination of the chest is mandatory and is accomplished at most induction stations by photoroentgenography. Although the maintenance of the health of the military forces is largely a matter of sanitation and immunization, induction center activities also contribute to the preventive medicine program. The roentgenologist's assistance in restoring the disabled to health is fundamentally the same, and just as great, as in any medical practice; adverse environmental factors and the necessity for speedy restoration to fighting efficiency work some modification, however.

That real and valuable help comes from roentgenologists is, then, self-evident. What has been done within the army to insure that this valuable aid be on a sound scientific basis? The number of qualified, well trained radiologists available is inadequate, hence a training program to meet this shortcoming, at least in part, has been set up.

The general training in clinico-roentgenology which anyone associated with

the roentgen department receives is, of course, present in military hospitals as well as in civilian institutions. Definitive training, however, is of greater interest: a six weeks' intensive basic course in roentgenology for medical officers is conducted at the Army School of Roentgenology; roentgenographic technicians are trained in several medical department technicians schools; a twelve weeks' "advanced" course in roentgenology forms part of the Mayo Foundation's instruction program for medical officers.

The purpose of the basic course at the Army School of Roentgenology is to train junior officers of the Medical Corps to serve as assistant roentgenologists. The majority of the students are ordered to the School because they are interested in taking the course or their duty assignment requires more knowledge of roentgen diagnosis than they possess. The basic training is composed of lectures, demonstrations, special problems, teaching seminars and applicatory exercises, chiefly in the form of practical examinations.

The main portion of the first two weeks' lecture program is devoted to physical and chemical fundamentals interspersed with several demonstrations and examinations. A particularly instructive type of examination is the small group, oral discussion of a number of different roentgenographic units; this serves to emphasize the practical importance of electrophysics. The remaining four weeks are devoted almost exclusively to diagnostic roentgenology. As each lecture subject comes to an end, a roentgenogram interpretation examination is held; the students are asked to render reports on a number of different roentgenographic studies and then those studies are discussed.

During the entire course, various "semi-

\* Presented before the Thirteenth Annual Conference of Teachers of Clinical Radiology, Chicago, Ill., June 6, 1943.



nars" are conducted; the class is divided into groups of about ten officers and each "seminar" is attended by a single group. This type of instruction is given in physics, foreign body localization, stereoscopy, trouble-shooting, roentgenoscopy, roentgenography, and roentgenogram interpretation.

Since the students are Army officers as well as doctors of medicine, drill, a retreat formation and a weekly inspection receive their due allotment of training time.

Each student is required to prepare a special problem for presentation to his class. Each student's special problem covers a narrow topic in roentgen diagnosis so that the literature on the subject can be reasonably reviewed. The presentation must include representative roentgenograms and a concise summary of roentgen findings as well as pertinent, collaborative data. A brief written report on each special problem is also submitted.

The evaluation of the student officers is based on personal contact with the teaching staff and special problem presentations as well as on the examinations. A report of each student's performance at the school is forwarded to his Commanding Officer and to the Surgeon General's Office.

The twelve weeks' course at the Mayo Foundation is intended as a continuation of the basic course or as added training for men with some previous roentgenological experience. The first two weeks are devoted to an intensive lecture series on the basic and clinical features of roentgenology. The following ten weeks are devoted to clinical observation, roentgenogram interpretation, quiz conferences and teaching seminars. Each student is required to attend all roentgenogram reporting sessions in addition to his rotating assignments in various roentgen department activities.

Several suggestions may be made as regards roentgenological training of young

men, who may ultimately enter the Service, but are at present undergoing instruction as civilians in civilian institutions.

The need in the Armed Forces is for roentgen diagnosticians; the more experience and training in diagnosis the man receives between now and his entry into the Service, the better will he help meet that need. Concentration of training on diagnosis is suggested. This is especially true in regard to roentgenoscopic approach to diagnosis.

A roentgenologist's high index of suspicion toward minimal reinfection type of tuberculosis stands the Armed Forces in good stead at the induction stations. Experience in diagnosis and in following progress of pulmonary tuberculosis is therefore important.

There should be at least a slight acquaintance with the roentgen manifestations of tropical diseases.

A working knowledge of electrophysics as applied to power sources and roentgenographic equipment will save time-consuming confusion in the event that direct, low frequency or polyphasic current sources are encountered. Improvised techniques, as well as equipment may well be the only means of keeping a roentgen department functioning; with service men available only after long waits, a knowledge of practical electrophysics again is useful. A knowledge of several makeshift foreign body localization techniques will not come amiss.

Efficient management of a roentgen department from the standpoint of expediting examinations and reports saves many hospital days. Since speedy restoration to good health and to full duty are of military significance, proper organization of a department will save not only hospital days but military effective days; acquisition of familiarity with the administration of a roentgenological department will pay worth while dividends.



## WAR TIME GRADUATE MEDICAL MEETINGS\*

By EDWARD L. BORTZ, CAPT. (MC) USNR.

**P**REVIOUS to the outbreak of war, it was my privilege to be associated with the postgraduate training activities of the American College of Physicians, as a member of the Committee on Postgraduate Courses. The College was setting up these courses in such places as the Mayo Clinic, the Continuation Center in Minneapolis, Harvard University, Johns Hopkins University and several other outstanding teaching centers throughout the country. They covered various special fields and lasted from one to six weeks and served as stimulating refresher courses for groups of men who felt they wanted such training.

Just about the time of the outbreak of war, when the military activity of the United States began its accelerated program, there began to appear a desire for postgraduate instruction for physicians already in the Service and those who were about ready to join the Armed Forces. As a result of these indications, certain inquiries were made and a few courses, under the auspices of the American College of Physicians, were established in the various special fields in Service hospitals, especially in the Philadelphia, Boston and Chicago areas.

The staffs and commanding officers of the hospitals received them most gratefully and offered recommendations that these courses be expanded.

### CREATION

As the result of these contacts with the Service doctors, a joint effort was made by the American Medical Association, the American College of Surgeons and the American College of Physicians to create a plan whereby similar courses in special branches of medicine might be carried to Service men all over the country. The main objective of the three organizations was to make available to the vast number of medical officers, who are not located near large

medical centers, the latest medical advances through short periods of instruction. It was a challenge to American medicine.

This plan was conceived not to displace the excellent teaching programs already established in many of the Service hospitals but it was designed to place at the disposal of these hospitals and medical officers everywhere the vast reservoir of present day medical knowledge.

It was the hope of the men creating this program that the periods of postgraduate instruction could be conducted by specialists in the various fields at Service hospitals where the need and desire for such courses were apparent. Such instruction would be carried there in the form of ward rounds, study groups, clinical demonstrations, moving pictures and question and answer periods.

Once the need was apparent and the facilities available whereby such courses could be organized, the committee, composed of one member from each of the three organizations, approached the Surgeons General of the Army, Navy and Public Health Service for authorization to proceed with the work. Their approval was given and the committee then felt free to advance the plan.

### ORGANIZATION

*Regional Committees.* With the work now ready to begin, the country was divided into twenty-four sections and for each section a committee of three was appointed. These men were selected by Brigadier General Fred Rankin, Brigadier General Hugh Morgan, Doctors James Paullin and Irvin Abell. They are doctors who have executive ability, know the civilian faculties and can implement the program in their particular area. With few exceptions, these seventy-two men responded affirmatively and enthusiastically.

The duties of the regional committee

\* Presented at the Thirteenth Annual Conference of Teachers of Clinical Radiology, Chicago, Ill., June 6, 1943.

members as outlined to them are as follows:

1. To be responsible for the details of programs at each Service hospital in their respective regions, where programs are to be conducted.

2. To be responsible for the selection of teachers and speakers, with the assistance of the Central Committee and of the National Consultants.

3. To arrange time of meetings and schedules of travel and appearance of the teachers within their respective territories.

4. To furnish copies of the programs to the Commanding Medical Officers of the hospitals.

5. Supervision of expenses, which shall be limited to necessary travel costs; also the forwarding of statements of same to the Secretary of the Central Committee.

6. To obtain from the Commanding Officers at the end of the period of instruction a written statement concerning their impressions, and those of their staff, regarding the value of the courses, and suggestions for improvement.

*National Consultants.* At the same time these physicians were appointed to serve on the regional committees, a group of thirty-four nationally known and outstanding men were invited to serve on the Board of National Consultants, covering thirty-one fields of medicine. Without exception these men accepted this invitation and have responded to the call for action.

The Board of National Consultants is composed of:

Robert A. Cooke—Allergy  
John S. Jundy—Anesthesia  
Lieut. Col. William P. Holbrook—Aviation medicine  
Louis H. Clerf—Broncho-esophagology  
William D. Stroud—Cardiovascular problems  
Chester S. Keefer—Chemotherapy  
Chester N. Frazier—Dermatology  
Lieut. Col. Thomas T. Mackie—Dysenteries  
Walter L. Palmer—Gastrointestinal diseases  
David P. Barr—General internal medicine  
Irvin Abell—General surgery  
Roy R. Kracke—Laboratory medicine  
Henry E. Meleney—Malaria  
Tracy J. Putnam—Neurology and neurosurgery  
John B. Youmans—Nutrition

Col. Harry S. Gradle—Ophthalmology  
George E. Bennett and Frank D. Dickson—Orthopedic surgery  
Capt. Harry P. Schenck—Otolaryngology  
Frank H. Krusen—Physical therapy  
Robert H. Ivy—Plastic and maxillofacial surgery  
Arthur H. Ruggles and Edward A. Strecker—Psychiatry  
John Romano—Psychosomatic medicine  
Col. B. R. Kirklin—Radiology  
Francis G. Blake—Respiratory diseases  
Ralph Pemberton—Rheumatism and arthritis  
Lieut. Col. Douglas B. Kendrick and Capt. Lloyd R. Newhouser—Shock, burns, blood derivatives  
Leo Eloesser—Thoracic surgery  
Frederick A. Collier—Traumatic surgery of the abdomen  
Col. Esmond R. Long—Tuberculosis  
Herman L. Kretschmer—Urology  
J. R. Heller—Venereal diseases

The duties of the National Consultants are:

1. Each Consultant to prepare a specimen six hour teaching schedule for a one day period.

2. To organize a National Faculty.

3. To cooperate with the regional committees in working out local programs and securing the teachers.

*Specimen Programs.* The first thing we asked the National Consultants to do was draw up a specimen program. They completed this task very promptly and we now have a group of programs that would be welcomed by any group of physicians seeking instruction.

These programs have been mimeographed and sent to the committee members, who will use them in drawing up programs for their own districts. They have likewise been sent to the Commanding Officers of the Army and Navy hospitals, the Surgeons General and to the leading men in American medicine. All have been exceptionally well pleased with the type of program submitted.

*National Faculty.* The National Faculty was organized in order to pool the Nation's outstanding teachers, and thereby meet the requirements of the various Service hospitals. It consists of civilian doctors and those men who are already in the Service, who

will be available through the cooperation of their Commanding Officers.

Obviously teachers of renown will not be asked to visit a camp or station where there are but three or four medical officers. On the other hand, plans are being built around hospitals where there are at least thirty-five medical officers, and to these meetings will be invited doctors from nearby medical establishments and also civilian physicians.

In addition to the men who are being contacted by the National Consultants, we have written to the deans of the medical schools and from fifty-five of them we have had enthusiastic responses practically placing their faculties at the disposal of the committee. Of course, through all these avenues there will be some duplication, but we do feel that in this way all of the outstanding men of medicine can be approached and their cooperation enlisted.

As you well know, a number of our fine teachers have tried every possible lane of approach to get into the Services today only to be ruled out for one reason or another. The War Time Graduate Medical Meetings, however, offer them the oppor-

tunity to come closer to the man in the Service by going out on a one, two, three or possibly seven day tour of the hospitals.

#### CONCLUSION

The interest on the part of the doctors, both civilian and those in the Services, in the medical meetings being offered is greater than ever before. There is a seriousness of application and a positive desire to gain knowledge of all new advances in medicine. Medical science today is progressing by leaps and bounds.

The effort and time expended by the Central Committee and the three organizations behind the War Time Graduate Medical Meetings have been doubly repaid by the enthusiasm and cooperation received. The urge to do something in behalf of American medicine to better equip doctors for carrying the highest type of modern scientific medicine directly to the front, where our boys are getting the best that medical science has to offer, is strong. Such a program, I believe, is eminently worth while and undoubtedly will prove most successful.



# A SIMPLE METHOD FOR MEASURING PEAK VOLTAGE IN DIAGNOSTIC ROENTGEN EQUIPMENT\*†

By RUSSELL H. MORGAN, M.D.  
CHICAGO, ILLINOIS

**D**URING the past several decades there has accumulated an extensive literature\* on methods for measuring roentgen voltage. Of the various procedures which have been suggested, most are based on the use of such instruments as the spark gap, the high resistance voltmeter, the electrostatic voltmeter, the spectrograph and the condenser voltmeter. Of these, the spark gap is probably the best known to radiologists. Its wide usage may be attributed to its simplicity of operation and a precision sufficiently great for most roentgenographic applications. Its principal disadvantages include tendencies toward erratic performance in the presence of surges and transients and during humid weather.

In recent years the spark gap has been replaced in many roentgen-ray laboratories by the more reliable high resistance voltmeter.<sup>9</sup> This latter instrument possesses high inherent precision and sufficient flexibility that it may be used to measure peak,<sup>10,11</sup> root mean square, and average volts. Furthermore, when adapted to cathode-ray oscillography<sup>12</sup> it simultaneously permits an examination of the voltage wave-form of a roentgen generator. Originally the high resistance voltmeter was a large bulky device. The immersion of the resistance elements in oil, however, allows a considerable reduction in the instrument's size.

The electrostatic voltmeter has found some use in therapeutic roentgenology. Since it measures root mean square rather than peak volts it is not suitable for roentgenographic calibrations.

The spectrograph and condenser volt-

meter have been more widely applied in Europe than in the United States. They are essentially laboratory instruments and do not possess the flexibility of the high resistance voltmeter.

In recent years the measurement of roentgen voltage has been complicated somewhat by the introduction of shock-proof equipment. In order to tap the high tension circuits of modern roentgen apparatus, auxiliary junction boxes and cables are necessary. This supplementary apparatus reduces considerably the practicability of making voltage measurements outside of a well equipped laboratory, and accordingly most roentgen machines are calibrated at the factory before installation.

Under certain circumstances peak voltage may be determined with sufficient precision for general roentgenographic purposes from absorption data. For example, Müller<sup>7</sup> suggests a method wherein peak voltage may be determined from half-value layer measurements. The outstanding advantage of methods based on the absorption principle is that no tapping of the roentgen circuits is required; furthermore, measurements may be made with relatively simple apparatus. These methods, therefore, are particularly well suited to radiologists who may wish to check the calibration of their machines from time to time, and to servicemen who are not infrequently called upon to calibrate roentgenographic equipment in the field.

A simple absorption method for measuring roentgen voltage has been used successfully in this laboratory for some time. The procedure is not dissimilar to that described by Duane<sup>2,3</sup> for determining the effective wave length of a roentgen beam. The ap-

\* An excellent review of this literature was published a few years ago by Müller.<sup>7</sup>

\* From the Division of Roentgenology, the University of Chicago.

† The work described in this paper was done under a contract recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the University of Chicago.

paratus required includes a direct-reading photoelectric roentgen-ray intensitometer\* similar in general design to the roentgenographic exposure meters previously described by the writer,<sup>6</sup> copper filters 0.5 and 1.0 mm. in thickness and aluminum filters 1 and 2 mm. in thickness. An ionometric intensitometer is equally suitable although the curves presented below strictly apply only to photoelectric intensitometers in which the radiation detector includes a phototube, a type B fluoroscopic screen, and an overlying aluminum filter 0.5 mm. in thickness. To make a voltage determination by means of this apparatus, the radiation detector of the intensitometer is placed beneath the roentgen tube to be tested at a target-detector distance of 1

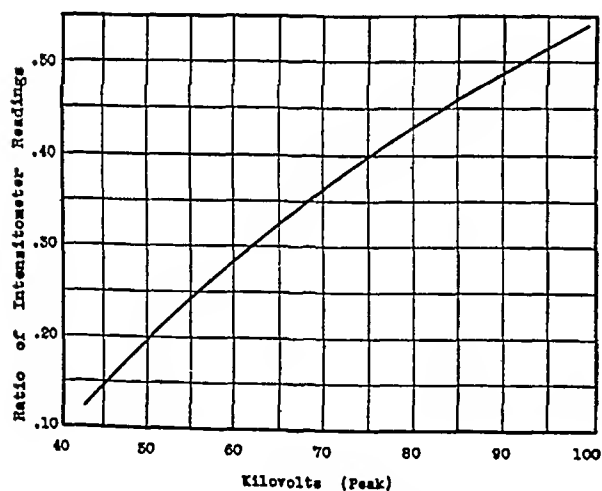


FIG. 1. Relation between peak roentgen kilovolts and the ratio of intensitometer readings made with 1.5 and 1.0 mm. of copper filtration.

\* As developed in this laboratory, the photoelectric intensitometer is constructed in two parts, a radiation detector and a meter unit. The radiation detector includes a phototube, preferably of the multiplier type, an overlying fluorescent screen, and an aluminum filter 0.5 mm. in thickness. The meter unit includes a microammeter with which the current developed by the phototube is recorded, and a power supply for the various intensitometer circuits. When the radiation detector is placed beneath a roentgen tube and a roentgen beam projected through it, the fluorescent screen is activated. In response to the fluorescent radiation the phototube conducts a small current which is recorded by the microammeter. The instrument is so designed that meter deflections are proportional to the intensity of the light emitted by the fluorescent screen, which in turn is a function of the intensity of the roentgen radiation. For exposure meter service it is convenient to calibrate the scale of the microammeter in terms of exposure time. When the intensitometer is to be used for the determination of roentgen voltage, however, it is preferable to calibrate the microammeter scale in arbitrary units of 0 to 100.

meter or more. Exposures are then made, first with 1.5 mm. of copper and then with 1 mm. of copper in the roentgen beam if the kilovoltage is suspected of being over 50 kv. (peak), and first with 3 mm. of aluminum and then with 2 mm. of aluminum if the kilovoltage is suspected of being below 50 kv. (peak). The deflection of the intensitometer is noted in each instance and the ratio of the two readings calculated. This determination is then applied to Figure 1 if cop-

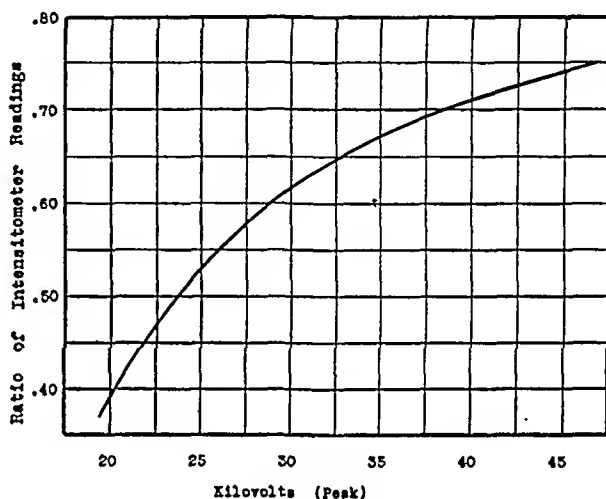


FIG. 2. Relation between peak roentgen kilovolts and the ratio of intensitometer readings made with 3.0 and 2.0 mm. of aluminum filtration.

per filtration has been used, or to Figure 2 if the measurements have been made with aluminum filtration. Peak kilovoltage is read directly from the curves. For example, suppose that roentgen-ray exposures made with 1.5 and 1 mm. of copper filtration in the roentgen beam produce intensitometer deflections of 26 and 69 divisions respectively. The ratio of the two readings is 0.38. An examination of Figure 1 indicates that the peak voltage applied to the roentgen tube was 73 kilovolts.

When taking intensitometer readings it is desirable to diaphragm the roentgen-ray beam in order to prevent possible error from scattered radiation. An aperture of 1.5 cm. has been found satisfactory if the diaphragm-radiation detector distance exceeds 30 cm. Under this condition the amount of scattered radiation reaching the

radiation detector is reduced to below 1 per cent of the total amount of radiation.

The exposure times with which the intensitometer readings are made are not critical so long as they exceed the time required for the microammeter needle to reach its resting position. When it is desired to use exposure times shorter than this the two exposures must be made with identical exposure times. If this precaution is observed readings made even with extremely short exposure times (e.g. 1/20 second) will not be in error.

The data from which Figures 1 and 2 were prepared were derived from copper and aluminum absorption curves made from measurements conducted with a photoelectric roentgen-ray intensitometer in which the radiation detector included a multiplier phototube, a type B fluorescent screen, and an overlying aluminum filter 0.5 mm. in thickness. The roentgen generator was a full wave, valve-rectified machine in which oscillographic tracings demonstrated that the minimum voltage was approximately 25 per cent of the peak voltage. The voltage applied to the roentgen tube during each determination was measured with a high resistance precision vacuum tube voltmeter.

The various copper absorption curves approached essentially straight-line characteristics for voltages below 100 kv. (peak) when the thickness of copper was 1 mm. or less. The aluminum absorption curves produced at and below 50 kv. (peak) approached straight-line characteristics when the thickness of aluminum was 2 mm. or less.\* In view of these observations it is evident that the curves presented in Figures 1 and 2 are essentially independent of the inherent filtration of present-day roentgen tubes, and also the wave-form of the roentgen generator. Comparative voltage measurements made with a high resistance

precision type voltmeter and a roentgen-ray intensitometer on self-rectified, mechanically rectified, and valve-tube rectified equipment may be expected to agree with one another within  $\pm 2$  per cent. This is a better correlation than may be obtained between measurements made with a precision high resistance voltmeter and a spark gap. It, therefore, is believed that the intensitometric method is sufficiently precise for general roentgenographic purposes.

#### SUMMARY

A simple method for measuring the peak kilovoltage applied to a roentgen tube is described. The apparatus required in the procedure includes a photoelectric intensitometer similar to the exposure meters described in previous communications, and a set of two aluminum and two copper filters. The method requires no tapping of the high tension roentgen circuits, and measurements may be made quickly and easily. The method, therefore, should be valuable not only to radiologists who wish to check their roentgen equipment from time to time, but also to servicemen who are called upon to calibrate roentgen apparatus in the field.

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\* These results are in good accord with those published by Taylor and Singer,<sup>3</sup> Holthusen and Gollwitzer,<sup>4</sup> and others,<sup>1,5</sup> when it is pointed out that the inherent filtration of the radiation detector of the intensitometer was approximately 1.5 mm. of aluminum, and that of the roentgen tube window was 0.5 mm. of aluminum.

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# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Twenty-eighth Annual Meeting: 1944, to be announced.

## JOINT MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY AND THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

**I**T HAS been a little over ten years since the combined societies of North America held the First American Congress of Radiology. At the time of that meeting a Century of Progress Exposition was being held in Chicago. All the world was then apparently at peace and while the Century of Progress was primarily an American exposition, many countries over the world had feature attractions; among the exhibitors were Italy, Japan, China, Sweden, Czechoslovakia, Ukrania, and Belgium. How long ago that seems in the light of the happenings of the last several years! China and Japan have been at war for seven years, starting a conflagration which soon spread to other nations until now most of the nations of the earth are at war and American citizens are scattered across the face of the globe participating in the gigantic struggle for what mankind calls freedom.

This year there is to be held a meeting of two of America's outstanding societies—the Radiological Society of North America and the American Roentgen Ray Society. Published elsewhere in this issue of the JOURNAL is a Preliminary Program of this Joint Meeting, which is to be held at the Palmer House in Chicago, Illinois, September 24 to 29, 1944. Dr. E. R. Witwer, President of the Radiological Society and Dr. L. C. Kinney, President-Elect of the American Roentgen Ray Society and their program committee have arranged, in spite of many difficulties, a most comprehensive program. Quite naturally, in view of the times, many of the subjects deal primarily with phases of roentgenology pertinent to

the war, and the United States Government has generously granted leave to members of the Armed Forces to participate in the Joint Meeting. Major General N. T. Kirk, Surgeon General of the Army will be personally represented by Colonel B. R. Kirklin, Vice Admiral Ross T. McIntire, Surgeon General of the Navy, by Lieutenant Commander Robert K. Arbuckle, and Dr. Thomas H. Parran, Surgeon General of the United States Public Health Service, by Dr. Waldron Sennott, P/A Surgeon, U.S.P.H.S.

The combined meeting of the two societies necessitates the arrangement of a program which lends itself to certain group discussions. Consequently the various scientific sessions will be held under a General Assembly, a Diagnostic Section and a Therapy Section. The grouping of the papers in this manner makes for easier attendance at the section in which one's interest primarily lies.

The two featured lectures of the societies—the Carman Lecture of the Radiological Society and the Caldwell Lecture of the American Roentgen Ray Society—have been combined as the Caldwell-Carman Lecture and this will be given on Tuesday evening. The banquet will be held on Thursday evening.

The Refresher Courses which have become a prominent feature of the meetings of both Societies will again be offered and in these courses there will be made available concentrated and specialized instruction in some of the more difficult and interesting phases of radiology. These courses

will be under the direction of highly qualified instructors. The detailed program of these Refresher Courses was published in the July issue of this JOURNAL, as well as in the July issue of *Radiology*.

The Scientific Exhibits promise to be of much importance covering many phases of the more recent developments and advances in diagnostic and therapeutic radiology. The Commercial Exhibits, too, give every promise of being extensive and im-

portant. Newer advances, many of which have resulted from experience gained in military activities, will be explained and demonstrated.

To all the interested members of the Armed Forces a cordial invitation is extended to attend this Joint Meeting.

It is suggested that all who anticipate attending the meeting should make their reservations at the Palmer House as soon as possible to avoid conflicts.





WILLIAM McDOWELL DOUGHTY  
1881—1944

DR. WILLIAM McDOWELL DOUGHTY, of Cincinnati, Ohio, a nationally known radiologist, died of coronary occlusion at his farm in Lawrenceburg, Indiana, on April 18, 1944, at the age of sixty-two. Dr. Doughty was born on November 4, 1881, in Covington, Ken-

tucky, and obtained his early education there. He attended Miami Medical College (now the Medical College of the University of Cincinnati) and was graduated from there in 1906. He served an eighteen months' internship at the Cincinnati General Hospital, after which he did post-

graduate work for one year in Vienna and London.

In addition to maintaining a private practice Dr. Doughty was Associate Professor of Radiology and Associate Director of the Department of Radiology at the College of Medicine of the University of Cincinnati and at General Hospital, and at the time of his death he was chief Radiologist at Christ Hospital and Senior Radiologist at Children's Hospital.

Dr. Doughty was not only an outstanding radiologist but he was one of Cincinnati's leading citizens, taking an active part in the civic affairs of the city. In 1936 he was made a member of the Board of Directors of the University of Cincinnati at which time he resigned his positions in the College of Medicine of the University. He was President of the Cincinnati Academy of Medicine in 1933 and President of the American Roentgen Ray Society in 1941-1942, the Society holding one of its most successful meetings in 1941 in Cincinnati under his presidency. He was also a

member of the American Medical Association, the Radiological Society of North America, the American College of Radiology, a diplomate of the American Board of Radiology, a life member of the American College of Surgeons, and he was a member of the Silicosis Board of Referees of the Industrial Commission of Ohio.

Dr. Doughty accomplished much during his life time and was the recipient of many honors. In all of his associations he gave more of himself than he received. He had the faculty of making friends and to him the making of a friend was a thing accomplished. He was primarily a physician, secondarily a specialist in radiology. He was considerate of his associates and he was at all times able to consider agreeably and weigh an opposing point of view. Dr. Doughty's wise counsel and friendly smile will be greatly missed both by those who were closely associated with him and by his many friends in the various groups and organizations to which he belonged.

E. R. BADER





## H. KENNON DUNHAM

1872—1944

**D**R. DUNHAM is dead. Certainly none could ever have said that about him until mortal life ceased in his body. An inquisitive investigator of zeal and enthusiasm, he sought the reasons and causes of things going on in the human chest, using the roentgen ray as his tool of study. When first he sought the answers for abnormal

densities noted on x-ray chest plates of patients with pulmonary tuberculosis, he realized that primarily must be known the normal; then and then only could be studied and understood the abnormal. He spent the greater part of two years, from 1915 to 1917, with Dr. William Snow Miller, anatomist of the University of Wis-

consin, mapping out the normal anatomy of the lungs, on microscopic slides and x-ray chest plates, at the same time building up an interpretation of the abnormal as studied by the same methods. By such methods of study it has become possible for us now to make mental dissections of the lungs of our living patients, as laid bare on chest roentgenograms. The contributions of anatomist, pathologist and clinician were joined, molding a basic pattern for the interpretation of abnormal roentgen-ray densities in terms of pathological tissue changes in the lungs. Such was his aim and accomplishment in life.

H. Kennon Dunham was born at Fairview, Ohio, March 3, 1872, son of Dr. William Henry and Mary (McPherson) Dunham. He married Amelia Hickenlooper of Cincinnati, March 14, 1905, and had two children; Harry, the only son, was killed in military action while flying in New Guinea. Amelia, the daughter, survives. Dr. Dunham was graduated in Medicine from the Miami Medical College in 1894, pursued post-graduate work at Johns Hopkins Hospital in 1896 and later at Great Ormand St. Hospital and St. George's Hospital in London in 1899. These researches were extended and finished at the University of Wisconsin in collaboration with Dr. William Snow Miller and Dr. Henry Bunting in 1915 to 1917. He was Associate Professor of Medicine, Head of the Department of Tuberculosis at the University of Cincinnati; Medical Director at the Hamilton County Tuberculosis Hospital from 1914 to 1940. He served in the Medical Corps of the U. S. Army during World War I as Captain and Major. He held the following responsi-

ble positions of honor: President, Cincinnati Academy of Medicine, 1921; President, Ohio Public Health Association, 1930-1932; President, National Tuberculosis Association, 1934-1935; President, Cincinnati Anti Tuberculosis League; Chairman, Cincinnati Christmas Seals Committee. He was a member of the American Medical Association, American College of Physicians (Fellow), Ohio State Medical Association, American Clinical and Climatological Association, American Association of Thoracic Surgery, American Trudeau Society, American Roentgen Ray Society, Radiological Society of North America, American College of Radiology (Fellow) and a diplomate of the American Board of Internal Medicine.

Dr. Dunham had been very active in the rehabilitation work of the Veterans Bureau, serving on the Medical Council for many years, and in the American Legion. Some of his last efforts were in this work. After returning home from a Committee Meeting of the National Tuberculosis Association in New York concerned with the problems of tuberculosis in veterans, he developed bronchopneumonia and was confined to his bed for five weeks. While convalescing from this acute illness an attack of coronary thrombosis occurred and he died suddenly on April 27, 1944, at his home in Cincinnati, Ohio.

He served and inspired others to serve. His interest and affiliations were wide but focused chiefly on the roentgen diagnosis of pulmonary tuberculosis and the control of this disease. His mark in these fields is permanent.

JOHN H. SKAVLEM



# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer.*

## MEETINGS OF ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary*, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Joint Meeting of American Roentgen Ray Society and Radiological Society of North America, Palmer House, Chicago, Ill., Sept. 24-29, 1944.

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary*, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary*, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio.

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary*, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Joint Meeting of American Roentgen Ray Society and Radiological Society of North America, Palmer House, Chicago, Ill., Sept. 24-29, 1944.

#### RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

*Secretary*, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

#### SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

*Secretary*, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.

#### RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

*Secretary*, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

#### SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

*Secretary*, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

#### RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION

*Secretary*, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

#### RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

*Secretary*, Dr. Roy G. Giles, Temple, Texas.

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary*, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N. Y. Meets monthly on fourth Tuesday, October to April.

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

#### CHICAGO ROENTGEN SOCIETY

*Secretary*, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary*, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary*, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.

#### DENVER RADIOLOGICAL CLUB

*Secretary*, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary*, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

#### FLORIDA RADIOLOGICAL SOCIETY

*Acting Secretary*, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary*, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

#### INDIANA ROENTGEN SOCIETY

*Secretary*, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meeting held the second Sunday in May annually.

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary*, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary*, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

#### NEBRASKA RADIOLOGICAL SOCIETY

*Secretary*, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

#### NEW ENGLAND ROENTGEN RAY SOCIETY

*Secretary*, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

#### RADIOLOGICAL SOCIETY OF NEW JERSEY

*Secretary*, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

#### NEW YORK ROENTGEN SOCIETY

*Secretary*, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

#### NORTH CAROLINA ROENTGEN RAY SOCIETY

*Secretary*, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

\* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.



**NORTH DAKOTA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

**CENTRAL NEW YORK ROENTGEN RAY SOCIETY**

*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

**OHIO RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. E. McCarthy, 707 Race St., Cincinnati. Meets at time and place of annual meeting of Ohio State Medical Association.

**PACIFIC ROENTGEN SOCIETY**

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

**PENNSYLVANIA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. L. E. Wurster, 416 Pine St., Williamsport.

**PHILADELPHIA ROENTGEN RAY SOCIETY**

*Secretary*, Dr. R. P. Barden, University Hospital. Meetings first Thursday of each month from October to May inclusive at 8:15 p.m., in Thompson Hall, College of Physicians, 19 S. 22d St.

**PITTSBURGH ROENTGEN SOCIETY**

*Secretary*, Dr. R. G. Alley, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 p.m., October to June, Pittsburgh Academy of Medicine.

**ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.**

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 p.m. at Strong Memorial Hospital.

**ROCKY MOUNTAIN RADIOLOGICAL SOCIETY**

*Secretary*, Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

**ST. LOUIS SOCIETY OF RADIOLOGISTS**

*Secretary*, Dr. E. W. Spinzig, 2646 Potomac, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

**SAN DIEGO ROENTGEN SOCIETY**

*Secretary*, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

**SAN FRANCISCO RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Martha Mottram, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 p.m., first six months of year at Toland Hall, University of California Hospital, second six months at Lane Hall, Stanford University Hospital.

**SHREVEPORT RADIOLOGICAL CLUB**

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 p.m., September to May inclusive.

**SOUTH CAROLINA X-RAY SOCIETY**

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

**TENNESSEE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

**TEXAS RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, January 17, 1945.

**UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING**

Meets each Monday evening from September to June, at 7 p.m. at University Hospital.

**UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE**

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 p.m., Room 301, Service Memorial Institute.

**VIRGINIA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

**WASHINGTON STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

**X-RAY STUDY CLUB OF SAN FRANCISCO**

*Secretary*, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

**CUBA****SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA**

*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

**BRITISH EMPIRE****BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY**

Medical Members' meeting held monthly on third Friday at 2:30 p.m. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

**SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)**

Meets on the third Friday of each month at 4:45 p.m. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

**FACULTY OF RADIOLOGISTS**

*Secretary*, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

**SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS**

*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

**RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION**

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

**CANADIAN ASSOCIATION OF RADIOLOGISTS**

*Secretary*, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton, Alberta.

**SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION**

*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

**RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION**

*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

**SOUTH AMERICA****SOCIEDAD ARGENTINA DE RADIOLOGIA**

*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

**CONTINENTAL EUROPE****SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA**

*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

**SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)**

*Secretary* for French language, Dr. A. Grosjean La Chaux de Fonds.

*Secretary* for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

**SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE**

*Secretary*, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. 1., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

**ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.**

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

**LENINGRAD ROENTGEN RAY SOCIETY**

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

**MOSCOW ROENTGEN RAY SOCIETY**

*Secretaries*, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 p.m.

**SCANDINAVIAN ROENTGEN SOCIETIES**

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology. meeting every second year in the different countries belonging to the Association.

# JOINT MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY AND THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

PALMER HOUSE, CHICAGO, ILLINOIS, SEPTEMBER 24-29, 1944

## PRELIMINARY PROGRAM

MONDAY, SEPTEMBER 25, 1944

### *General Assembly*

10:30 A.M.

Sherwood Moore, M.D., President, American  
Roentgen Ray Society, Presiding.

H. Dabney Kerr, M.D., Secretary of Session.

1. Call to Order. Sherwood Moore, M.D., St.  
Louis, Missouri.

2. Greetings. Josiah J. Moore, M.D., President,  
Chicago Medical Society, Chicago, Illi-  
nois.

3. Response. Eldwin R. Witwer, M.D., Chair-  
man Coordinating Committee, Detroit,  
Michigan.

4. Address: "A Study of the Ureters in Bladder  
Neck Obstructions." Herman L. Kretsch-  
mer, M.D., President, American Medical  
Association, Chicago, Illinois, and Fay H.  
Squire, M.D., Chicago, Illinois.

5. Address: Colonel B. R. Kirklin, M.C.,  
A.U.S., representing Major General Nor-  
man T. Kirk, Surgeon General, M.C.,  
A.U.S., Washington, D. C.

6. Address: "Pantopaque Myelography: Cor-  
relation of Roentgenological and Neuro-  
surgical Findings." Lieutenant Com-  
mander Robert K. Arbuckle, M.C.,  
U.S.N.R., representing Vice Admiral Ross  
T. McIntire, Surgeon General, M.C., U. S.  
Navy, and Lieutenant C. H. Shelden,  
M.C., U.S.N.R., and Lieutenant R. H.  
Pudenz, M.C., U.S.N.R., Bethesda, Mary-  
land.

MONDAY AFTERNOON, SEPTEMBER 25, 1944

### *Diagnostic Section*

2:00 P.M.

Group of Papers pertaining  
to CHEST

Eldwin R. Witwer, M.D., Presiding.

David Beilin, M.D., Secretary of Session.

1. "Progressive Bilateral Bullous Emphysema"  
George Teplick, M.D. (by invitation), and  
Allison Price, M.D. (by invitation), Phila-  
delphia, Pa.

2. "Non-disabling Bronchiectasis." Major  
Archie Fine, M.C., A.U.S., National  
Army Air Center, Nashville, Tenn.

3. "Roentgenograms of the Chest in Mental  
Deficiency." Joseph T. Danzer, M.D., Oil  
City, Pa.

RECESS 3:30 to 4:00 P.M.

### *Review Exhibits*

4. "Planigraphy. III. An Evaluation of the  
Method in the Diagnosis of Cancer of the  
Lower Respiratory Tract." J. Robert An-  
drews, M.D., Cleveland, Ohio, and Cap-  
tain Robert O. Turck, M.C., A.U.S. (by  
invitation).

5. "The Roentgenological Aspect of Tubercu-  
lous Calcification. A Clinical and Experi-  
mental Study." Robert G. Bloch, M.D.  
(by invitation), Chicago, Illinois.

6. "Miniature Chest Fluorography with Con-  
trol Study." Harry Hauser, M.D., and  
Carroll C. Dundon, M.D. (by invitation),  
Cleveland, Ohio.

MONDAY AFTERNOON, SEPTEMBER 25, 1944

### *Therapy Section*

2:00 P.M.

U. V. Portmann, M.D., Presiding.

John S. Bouslog, M.D., Secretary of Session.

1. "The Value of Orchidectomy in the Treat-  
ment of Carcinoma of the Male Breast."  
T. Leucutia, M.D., Detroit, Michigan.

2. "Testicular Irradiation in Carcinoma of the  
Prostate." Arbor D. Munger, M.D. (by  
invitation), Lincoln, Nebraska.

3. "An Improved Technique for the Treatment  
of Carcinoma of the Testis." Major Mil-  
ton Friedman, M.C., A.U.S., and Lieuten-  
ant Colonel L. G. Lewis, M.C., A.U.S. (by  
invitation), Washington, D. C.

RECESS 3:30 to 4:00 P.M.

### *Review Exhibits*

4. "A Review of Sixty-five Cases of Malignant

Tumors of the Testes." Major J. L. Barner, M.C., A.U.S., Atlanta, Georgia.

5. "Contact Roentgen Therapy for Carcinoma of the Bladder." Lowell S. Goin, M.D., Los Angeles, Calif.
6. "Roentgen Therapy in the Treatment of Marie-Strümpell Spondylarthritis (Spondylitis Rhizomelica)." Robert J. Reeves, M.D., and James E. Hempill, M.D. (by invitation), Durham, North Carolina.

TUESDAY, SEPTEMBER 26, 1944

*General Assembly*

10:30 A.M.

Eldwin R. Witwer, M.D., Presiding.

Donald S. Childs, M.D., Secretary of Session.

1. Installation of the President-Elect of the American Roentgen Ray Society, Lyell C. Kinney, M.D., San Diego, California, by Sherwood Moore, M.D., President, American Roentgen Ray Society and Charles W. Heacock, M.D., Chairman, Executive Council, American Roentgen Ray Society.
2. Inaugural Address. Lyell C. Kinney, M.D., President, American Roentgen Ray Society.
3. "The Roentgen-Ray Examination in the Urinary Tract with Special Reference to Methods and Findings in Cases of Testicular Tumors." Lieutenant Colonel Joseph C. Bell, M.C., A.U.S., Major Gilbert J. Heublein, M.C., A.U.S. (by invitation), and Captain Howard J. Hammer, M.C., A.U.S. (by invitation), Percy Jones General Hospital, Battle Creek, Michigan.
4. "X-Ray Findings in Chest Examinations of 120,000 Government Employees." Waldron Sennott, M.D., P/A Surgeon, U.S.P.H.S., United States Marine Hospital, Staten Island, N. Y., representing Surgeon General Thomas H. Parran, U.S.P.H.S.
5. "Radiation Necrosis of the Skull." Lieutenant Commander John D. Camp, M.C., U.S.N.R., United States Naval Hospital, Oakland, California.
6. "Coccidioides Infection of the Lungs." Lieutenant Colonel John L. Davis, M.C., A.U.S. (by invitation), Captain Ivan H. Munk, M.C., A.U.S. (by invitation), and Captain Samuel H. Boyer, M.C., A.U.S.

(by invitation), Camp Haan, Riverside, California.

TUESDAY AFTERNOON, SEPTEMBER 26, 1944

*Diagnostic Section*

2:30 P.M.

Group of Papers Pertaining to GASTRO-INTESTINAL TRACT

Lyell C. Kinney, M.D., Presiding.

Chas. W. Heacock, M.D., Secretary of Session.

1. "Antral Gastritis: Roentgenologic and Gastroscopic Findings." Walter W. Vaughan, M.D., Durham, N.C.
2. "Congenital Duodenal Obstruction." Ernest Kraft, M.D., Friedrich G. Kautz, M.D. (by invitation), and James R. Lisa, M.D. (by invitation), New York, N.Y.
3. "Diaphragmatic Hernia and Dilated Esophageal Ampulla; Their Clinical Significance." Jacob Abowitz, M.D., Los Angeles, California.
4. "Diverticula of the Small Intestine." Max Ritvo, M.D., Boston, Mass.
5. "Regional Ileitis." Samuel Brown, M.D., Cincinnati, Ohio.
6. "Differential Diagnosis Between Benign and Malignant Gastric Ulcers." Lewis Gregory Cole, M.D., White Plains, New York.

TUESDAY AFTERNOON, SEPTEMBER 26, 1944

*Therapy Section*

2:30 P.M.

Heddy S. Shoulders, M.D., Presiding.

James N. Collins, M.D., Secretary of Session.

1. "Hematological and Clinical Characteristics of Leukemias." Russell L. Haden, M.D. (by invitation), Cleveland, Ohio.
2. "Clinical and Hematological Observations on One Hundred Patients with Various Types of Blood Dyscrasias Treated with Radioactive Phosphorus." E. H. Reinhard, M.D., and C. V. Moore, M.D. (by invitation), St. Louis, Missouri.
3. "Leukemia—Results of Roentgen Treatment." Bernard P. Widmann, M.D., Philadelphia, Pa.
4. "The Experimental Production of Leukemia with Roentgen Rays." P. S. Henshaw, Ph.D. (by invitation), Bethesda, Maryland.
5. "Some Studies with Radioactive Sodium in Leukemic and Non-leukemic Mice." Edith

H. Quimby, M.Sc., and Titus C. Evans, Ph.D. (by invitation), New York, N. Y.

6. "Metabolic Changes Produced in Humans by Roentgen Rays." (To be read by title.) Anna Goldfeder, M.D. (by invitation), New York, N. Y.

TUESDAY EVENING, SEPTEMBER 26, 1944

8:30 P.M.

Grand Ball Room  
Caldwell-Carman Lecture  
Lawrence Reynolds, M.D.  
Detroit, Michigan

WEDNESDAY, SEPTEMBER 27, 1944

*General Assembly*

10:30 A.M.

Lyell C. Kinney, M.D., Presiding.

H. Dabney Kerr, M.D., Secretary of Session.

1. Address: Eldwin R. Witwer, M.D., President Radiological Society of North America, Detroit, Michigan.
2. "Some Considerations Concerning the Roentgen Examination of the Head." Eugene P. Pendergrass, M.D., and Charles R. Perryman, M.D. (by invitation), Philadelphia, Pa.
3. "Radiological Aspects of Public Health Work." Herman E. Hilleboe, M.D. and Russell H. Morgan, M.D. (by invitation), Bethesda, Maryland.
4. "The Roentgen Changes Associated with Pancreatic Fibrosis." Edward D. Neuhauser, M.D. (by invitation), Boston, Massachusetts.
5. "Radioactive Sodium as a Tracer in the Study of Peripheral Vascular Disease." Beverly C. Smith, M.D. (by invitation), and Edith H. Quimby, M.Sc., New York, N. Y.
6. "Streamlining Roentgen Therapy for War Time Service." Captain Albert Soiland, M.C., U.S.N.R., United States Naval Hospital, Long Beach, California.
7. Roentgen Demonstration of Cecal Deformity in Amebiasis." Ross Golden, M.D., and Paul H. Ducharme, M.D. (by invitation), New York, N. Y.

WEDNESDAY AFTERNOON, SEPTEMBER 27, 1944

*Diagnostic Section*

2:00 P.M.

Group of Papers Pertaining to  
OSSEOUS SYSTEM

Edgar P. McNamee, M.D., Presiding.

Harold G. Reineke, M.D., Secretary of Session.

1. "Differential Diagnosis of Tuberculosis in Joints of the Extremities." Raymond W. Lewis, M.D., New York, N. Y.
2. "Derangements of the Knee. The Diagnostic Scope of Soft Tissue Examination with the Vacuum Technique." Lieutenant Commander J. Gershon-Cohen, M.C., U.S.N.R., U. S. Naval Hospital, Sampson, N. Y.
3. "Post Traumatic Para-Articular Calcifications and/or Ossifications of the Ankle." Captain Arnold D. Piatt, M.C., A.U.S., Fort Myers, Florida.

RECESS 3:30 TO 4:00 P.M.

*Review Exhibits*

4. "The Development of Bone Sarcoma Following Irradiation." C. Howard Hatcher, M.D. (by invitation), Chicago, Illinois.
5. "Lesions of the Intervertebral Disc in the Cervical Region." J. E. Whiteleather, M.D., R. E. Semmes, M.D. (by invitation), and Francis Murphy, M.D. (by invitation), Memphis, Tenn.
6. "Roentgenographic Observations in Age Atrophy (Osteoporosis) of the Spine." G. J. Marum, M.D. (by invitation), Greenville, Miss.
7. "Deossifications Regional to Joints of Extremities." Colonel A. A. de Lorimer, M.C., A.U.S., Memphis, Tenn.

WEDNESDAY AFTERNOON, SEPTEMBER 27, 1944

*Therapy Section*

2:00 P.M.

Robert S. Stone, M.D., Presiding.

Edgar C. Baker, M.D., Secretary of Session.

1. "Roentgen Therapy for Brain Tumors." Percival Bailey, M.D. (by invitation), and T. J. Wachowski, M.D. (by invitation), Chicago, Illinois.
2. "Roentgen Therapy of Primary Neoplasm of the Brain and Brain Stem." C. B. Peirce, M.D., W. V. Cone, M.D. (by invitation), A. E. Elvidge, M.D. (by invitation),

tion), and J. C. Tye, Jr., M.D. (by invitation), Montreal, Canada.

3. "Neurosurgical Treatment of Patients with Advanced Malignant Diseases." Gayle Crutchfield, M.D. (by invitation), University, Virginia.

RECESS 3:30 TO 4:00 P.M.

*Review Exhibits*

4. "Irradiation of Pituitary Tumors." W. S. Lawrence, M.D., Memphis, Tennessee.
5. "Roentgen Therapy for Encephalitis." U. V. Portmann, M.D., and Roger Lough, M.D. (by invitation), Cleveland, Ohio.
6. "Simplification of Tissue Dose Estimation in Roentgen Therapy." Anna Hamann, M.D. (by invitation), Chicago, Illinois.

THURSDAY, SEPTEMBER 28, 1944

*General Assembly*

10:30 A.M.

Eldwin R. Witwer, M.D., Presiding.

Donald S. Childs, M.D., Secretary of Session.

1. "The Morgan X-Ray Exposure Meter and Phototimer." Paul C. Hodges, M.D., Chicago, Illinois.
2. "Scout Film of the Abdomen." Lieutenant Colonel Joseph Levitin, M.C., A.U.S., Camp Cooke, California.
3. "Clinical Cineradiography—Brazilian Method." Jose Jany, M.D. (by invitation), and Joaquin Martins Garcia, M.D., Radiologist, Official Delegate Ministerio Aeronautics (by invitation), Sao Paulo, Brazil.
4. "Analysis of Factors Affecting the Diagnostic Quality of the Roentgen Image." Russell H. Morgan, M.D. (by invitation), Bethesda, Maryland.
5. "The Importance of Recognizing Protrusions of the Gastric Mucosa in Military Personnel." Commander Wendell G. Scott, M.C., U.S.N.R., United States Naval Hospital, Seattle, Washington.
6. "Abdominal Aortography—A New Simplification of the Technique." Pedro L. Farinas, M.D., Habana, Cuba.

THURSDAY AFTERNOON, SEPTEMBER 28, 1944

*Diagnostic Section*

2:30 P.M.

Group of Papers pertaining to HEAD

Lewis G. Allen, M.D., Presiding.

W. Walter Wasson, M.D., Secretary of Session.

1. "The Roentgen Anatomy of the Skull in the

Newborn Infant." Samuel G. Henderson, M.D., and Louise M. Sherman, M.D. (by invitation), Pittsburgh, Pa.

2. "Midline Anomalies of the Brain." Arthur P. Echternacht, M.D., and John A. Campbell, M.D. (by invitation), Indianapolis, Ind.
3. "Lesions of the Aqueduct of Sylvius." Hugh M. Wilson, M.D. (by invitation), New Haven, Conn.
4. "Tuberous Sclerosis of the Brain." A. W. Marcovich, M.D. (by invitation), and Earl Walker, M.D. (by invitation), Chicago, Illinois.
5. "Observations on the Presence of Subdural Gas after Pneumoencephalography." Lester W. Paul, M.D., and T. C. Erickson, M.D. (by invitation), Madison, Wisconsin.

THURSDAY AFTERNOON, SEPTEMBER 28, 1944

*Therapy Section*

2:30 P.M.

Zoe A. Johnston, M.D., Presiding.

Leland E. Holly, M.D., Secretary of Session.

1. "Results of Irradiation Treatment of Ovarian Tumors." H. Dabney Kerr, M.D., and R. A. J. Einstein, M.D. (by invitation), Iowa City, Iowa.
2. "The Problem of Secondary Infection in Carcinoma of the Cervix." Manuel Garcia, M.D. (by invitation), and J. V. Schlosser, M.D. (by invitation), New Orleans, La.
3. "Irradiation Failures in Early Carcinoma of the Cervix—Is Surgery or Irradiation Preferable?" Franz Buschke, M.D. (by invitation), and S. T. Cantril, M.D., Seattle, Washington.
4. "Indications and Limitations of Transvaginal Roentgen Therapy for Cancer of the Cervix." Arthur W. Erskine, M.D., Cedar Rapids, Iowa.
5. "Bone Tumors—A Review of Cases from Bellevue Hospital, New York." Rieva Rosh, M.D., and Louis Raider, M.D. (by invitation), New York, N. Y.

THURSDAY EVENING, SEPTEMBER 28, 1944

8:00 P.M.

*Banquet*

Grand Ball Room

Edward L. Jenkinson, M.D., Presiding, Chicago, Illinois.

Speaker: Doctor Franklyn B. Snyder, President  
Northwestern University, Chicago, Illinois.

FRIDAY, SEPTEMBER 29, 1944

*General Assembly*

10:30 A.M.

Lyell C. Kinney, M.D., Presiding.

H. Dabney Kerr, M.D., Secretary of Session.

1. "Osteochondritis Dissecans of the Supratrochlear Septum of the Humerus." Lieutenant Commander W. E. Crysler, A/Surgeon, R.C.N.V.R. (by invitation), and Surgeon Commander H. S. Morton, R.C.N.V.R. (by invitation), Esquimalt, British Columbia.
2. "Subcortical Cyst-like Lesions of Joints." Dallas B. Phemister, M.D. (by invitation), Chicago, Illinois.
3. "Cardiac Changes in Arteriovenous Fistula." Major R. C. Pendergrass, M.C., A.U.S., Ashford General Hospital, White Springs, Virginia.
4. "Cystourethrography." Fred O. Coe, M.D., Washington, D. C.
5. "The Roentgenological Aspects of Therapeutic Pneumoperitoneum." Ernest A. Schmidt, M.D., Denver, Colorado.
6. "Relaxation of Intrinsic Spasm in Pyloroduodenal Area." Lester A. Smith, M.D., Indianapolis, Indiana.

FRIDAY AFTERNOON, SEPTEMBER 29, 1944

*Diagnostic Section*

2:30 P.M.

*Miscellaneous Papers*

Eldwin R. Witwer, M.D., Presiding.

Warren W. Furey, M.D., Secretary of Session.

1. "Roentgen Appearances in Collapse of the Lung and its Subdivisions. A Preliminary Report." Laurence L. Robbins, M.D. (by invitation), and Clayton H. Hale, M.D. (by invitation), Boston, Mass.
2. "Gas Gangrene." Captain Maurice D. Sachs, M.C., A.U.S., Port of Embarkation, San Francisco, Calif.
3. "Extrapleural Pneumothorax in the Treatment of Pulmonary Tuberculosis. Three to Five Year Follow Up of 48 Cases." F. H. Alley, M.D. (by invitation), Memphis, Tenn.
4. "Some Experiences with Angiography." Earl R. Miller, M.D., San Francisco, Calif.

5. "Specifications for the Fluoroscopist's Dark Adaptation Goggles." W. Edward Chamberlain, M.D., and Ann Chamberlain (by invitation), Philadelphia, Pa.
6. "Unusual Urinary Calculi." E. J. Bertin, M.D., Philadelphia, Penna.

FRIDAY AFTERNOON, SEPTEMBER 29, 1944

*Therapy Section*

2:00 P.M.

Charles H. Heacock, M.D., Presiding.

Clyde K. Hasley, M.D., Secretary of Session.

1. "The Treatment of Hemangiomas." G. E. Pfahler, M.D., Sc.D., L.L.D., Philadelphia, Penna.
2. "Treatment of Hemangioma with Roentgen Rays." James V. Prouty, M.D., Cedar Rapids, Iowa.
3. "Cancer of the Skin." Henry J. Ullmann, M.D., Santa Barbara, California.
4. "Post-irradiation Cutaneous Necrosis. A Study of its Mechanism, Course and Treatment." H. B. Hunt, M.D., and D. H. Breit, M.D. (by invitation), Omaha, Nebraska.
5. "The Radon Ointment Treatment of Irradiation Ulcers." Robert E. Fricke, M.D., and Marvin M. D. Williams, Ph.D. (by invitation), Rochester, Minn.
6. "Evaluation of Roentgen Therapy for Filariasis." Lieutenant H. L. Jaffe, M.C., U.S.N.R. (by invitation), San Diego, Calif.

## AMERICAN ROENTGEN RAY SOCIETY

This is an official notice to the members of the American Roentgen Ray Society that the Forty-fourth Annual Meeting of the Society will be held at the Palmer House, Chicago, Illinois, September 24-29, 1944. This is a joint meeting with the Radiological Society of North America.

The Executive Council Meeting of the American Roentgen Ray Society will be held in Private Dining Room No. 5 on September 24, 1944, at 10 A.M.; Scientific Sessions (Joint Meeting), Grand Ballroom, 10:30 A.M., September 25-29; Executive Business Sessions, Grand Ballroom, 4:30 P.M., September 26 and 28; Caldwell-

Carman Lecture, Grand Ballroom, 8:30 P.M., September 26; Annual Banquet, Grand Ballroom, 8:00 P.M., September 28. Refresher Courses daily Sunday, September 24, through Friday, September 29. Complete program of these courses published in the July, 1944, issue of this JOURNAL.

Communications relative to business matters of the American Roentgen Ray Society should be addressed to the Executive Council, in care of its Chairman, Dr. Charles H. Heacock, 915 Madison Avenue, Memphis, Tennessee, to arrive not later than September 21.

H. DABNEY KERR, *Secretary*

#### SECTION ON RADIOLOGY OF THE AMERICAN MEDICAL ASSOCIATION

At the meeting of the American Medical Association held in Chicago, Illinois, June 12-16, 1944, the following officers were elected in the Section on Radiology for the ensuing year: *Chairman*, Dr. Edwin C. Ernst, St. Louis, Mo.; *Secretary*, Dr. U. V. Portmann, Cleveland, Ohio; *Executive Committee*, Dr. Edwin C. Ernst, St. Louis, Mo., Dr. Raymond C. Beeler, Indianapolis, Ind.,

Dr. Robert A. Arens, Chicago, Ill.; *Representative to the American Board of Radiology*, Dr. John W. Pierson, Baltimore, Md.; *Member of the House of Delegates from the Section*, Dr. B. R. Kirklin, Rochester, Minn.

#### TEXAS RADIOLOGICAL SOCIETY

At the annual meeting of the Texas Radiological Society held in San Antonio, Texas, May 3, 1944, the following officers were elected for the period ending with the next annual meeting to be held on January 17, 1945, in Temple, Texas: *President*, Dr. P. E. Wigby, Houston; *President-Elect*, Dr. T. B. Bond, Fort Worth; *First Vice-President*, Dr. Herman Klapproth, Sherman; *Second Vice-President and Program Chairman*, Dr. C. A. Stevenson, Temple; *Secretary-Treasurer*, Dr. Asa E. Seeds, Dallas.

#### NEW ENGLAND ROENTGEN RAY SOCIETY

At the annual meeting of the New England Roentgen Ray Society held on May 19, 1944, the following officers were elected: *President*, Dr. Hugh F. Hare, Boston; *Secretary-Treasurer*, Dr. George Levene, Boston.



## DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.  
Charleston, S. C.

## CHART FOR LOCATING COMMON CAUSES OF BREAKDOWNS OF ROENTGENOLOGIC EQUIPMENT\*

By CARL B. BRAESTRUP

New York, New York

MANY radiologists today are faced with the problem of keeping their roentgenologic equipment in operating condition with only limited or no maintenance service from the manufacturer. When breakdowns occur the causes may in many cases not be obvious without a systematic search of all possible sources of improper operation of the equipment. The chart of Figure 1 was designed as a guide for roentgenologists and technicians in trouble shooting. It has been in use in the Department of Hospitals, New York City, for about two years and is based upon our experiences with more than two hundred roentgen-ray machines of various

makes and types. The chart has purposely been limited to the more common sources of trouble and to the usual type of equipment.

Directions: Look under "Symptoms of Trouble" for the condition which best describes the abnormal operation of the equipment. The numbers on the same horizontal line indicate the most likely causes in order of their probability with check marks showing other possible sources of improper operation.

630 West 168th Street  
New York 32, New York

\* From Physics Laboratory, Department of Hospitals, New York.

# DIAGNOSIS OF TROUBLE

## NOTE

THE NUMBERS  
INDICATE THE  
ORDER OF PROBABILITY  
OF THE MOST LIKELY  
CAUSES OF THE TROUBLE.  
THE CHECK MARKS (✓)  
SHOW OTHER POSSIBLE  
SOURCES OF THE IMPROPER  
OPERATION OF THE EQUIPMENT.

a.-1 OR 2 VALVE GENERATORS ONLY.

b.-4 VALVE EQUIPMENT ONLY.

## SYMPTOMS OF TROUBLE

AUTO TRANSFORMER NOT ENERGIZED (NO HUM)

PRIMARY VOLTMETER DOES NOT READ

" " LOAD READING LOW

" " FLUCTUATES

X-RAY TUBE FILAMENT DOES NOT LIGHT UP

" " METER DOES NOT READ

" " FLUCTUATES

" " OFF SCALE (TOO HIGH)

VALVE " DOES NOT LIGHT UP

" " METER DOES NOT READ

" " ANODE HEATS UP

OVERLOAD CIRCUIT BREAKER OPENS

NO HIGH TENSION (NO BRUSH DISCHARGE)

MILLIAMMETER (M.A.S. METER) DOES NOT READ

" " TOO LOW

" " FLUCTUATES

" " OFF SCALE (TOO HIGH)

INCONSISTANT RADIOGRAPHIC RESULTS

## NOTE

THE NUMBERS INDICATE THE ORDER OF PROBABILITY OF THE MOST LIKELY CAUSES OF THE TROUBLE. THE CHECK MARKS (✓) SHOW OTHER POSSIBLE SOURCES OF THE IMPROPER OPERATION OF THE EQUIPMENT.

a.-1 OR 2 VALVE GENERATORS ONLY.

b.-4 VALVE EQUIPMENT ONLY.

FIG. 1. Chart for locating common causes of breakdowns of roentgenologic equipment.



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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN DIAGNOSIS

### HEAD

EVANS, WILLIAM A., JR. An encephalographic ratio for estimating the size of the cerebral ventricles; further experience with serial observations. *Am. J. Dis. Child.*, Nov., 1942, 64, 820-830.

Evans, in a previous communication, proposed an encephalographic ratio for estimating the size of the cerebral ventricles and the degree of atrophy of the brain. The ratio was obtained by dividing the transverse diameter of the anterior horns by the maximum internal diameter of the skull. Measurements were made on encephalographic roentgenograms exposed in the anteroposterior projection at 30 inches with the patient horizontal and the occiput down. Considerations of magnification by projection were dealt with and the results in 212 cases were reported. In a "normal" group the great majority of the values for the ratio fell between the 0.20 and 0.25, and a statistical correlation was obtained between the diameter of the anterior horns and the internal diameter of the skull indicating that the ratio was not influenced by age or by the size of the skull. Values of the ratio between 0.25 and 0.30 were thought to represent borderline enlargement and those above 0.30 a pathologic ventricular dilatation.

In the present paper Evans reports the results of an investigation to test the effect of some technical factors and common clinical procedures on the measurements used in the ratio and of serial studies on patients to learn, if possible, the effect of varying quantities of air in the ventricles and other factors on the constancy of the ratio in the same subject.

In the first group of patients he endeavored to obtain the effect of obliquity of exposure on the value of the ratio, the skull being held in various oblique projections. His results indicate that degrees of obliquity greater than those which would be encountered in exercising moderate technical care do not produce important changes in the value of the ratio.

In another group of patients observations were made before and immediately after the withdrawal of as much spinal fluid as could be obtained. No constant or significant effect was observed in the size of the ventricles on withdrawal of the fluid. He regards this of interest, inasmuch as the spinal fluid pressure is commonly elevated after encephalography and the postencephalographic headache is commonly relieved by withdrawing spinal fluid.

In a third group of cases no effect could be observed of the size of the ventricles as expressed in the encephalographic ratio on injection of 50 cc. of a 50 per cent sucrose solution intravenously. Such solutions are sometimes used with the thought of decreasing cerebral edema and lowering intracranial pressure.

Serial studies were made over short and long periods after the air injection. It is concluded that serial determinations of the encephalographic ratio indicate a constant basis for mensuration, even with great variations in the amount of air. The roentgen exposure should be made in the anteroposterior projection in the sagittal plane with the ray vertical and with the head held with the occiput down, so that a vertical line will pass through the outer canthus of the eye and the external auditory meatus.

Many subjects showed no change in the measurements at the three and twenty-four hour periods, but in the majority there was a tendency for the ventricles to increase slightly in size in the presence of air.

The dilatation was much more pronounced in the presence of an active diffuse cerebral lesion, in which case a rapid and irreversible dilatation of the ventricles may occur.

Evans recommends that serial measurements be made for forty-eight or seventy-two hours in pneumoencephalography. If no change in the measurements occurs, the presumption is that any diffuse cerebral lesion which may be present is "fixed." If the ventricles enlarge, there is presumptive evidence that the lesion is active and progressive. The rate of enlargement seems to be proportional to the degree of "softening" of the brain.—R. S. Bromer.

DAVIES, HUGH. Report on a series of cases of head injury investigated by encephalography. *Brit. J. Radiol.*, Aug., 1942, 15, 238-242.

The author reports a series of 150 cases of head injury sufficiently severe to require examination at a special clinic. Air was used for the encephalography in the majority of cases, oxygen in a few. The cisternal route was used in all but 14 of the cases, in which the lumbar route was used. The views were the standard Lysholm projections. Details of the technique are described. In comparing encephalograms from different sources it is necessary to take into consideration whether the air-filled part of the ventricles is nearest to or farthest from the film.

In cerebral concussion there are no changes in the outline of the ventricles; there is dilatation after contusion, greatest in the damaged area. If there has been damage to a large vessel a cerebral cyst will result. Cerebral atrophy, which occurred in a large number of cases, is indicated by increase in content of the subarachnoid space. Probably the chief factor in causing dilatation of the ventricles is damage to the vessels either within the brain tissue or in the subarachnoid space.—*Audrey G. Morgan.*

BOWER, L. E., DITKOWSKY, S. P., KLIEN, BERTHA A., and BRONSTEIN, L. P. Arteriovenous angioma of mandible and retina with pronounced hematemesis and epistaxis. *Am. J. Dis. Child.*, Dec., 1942, 64, 1023-1029.

A case is reported of epistaxis accompanied by emesis of swallowed blood, the cause of which was an arteriovenous angioma of the mandible associated with a similar lesion of the retina. Roentgenograms of the jaw revealed a large cystic area in the left mandible. Nine months later a roentgenogram failed to reveal any bony defect. This was explained on the basis of fibrotic changes which occurred secondary to an infection of the cystic area. The patient had a localized, angiomatous malformation of the retina of the anterior venous type as indicated by the visible retinal portion of the lesion, and by the presence of a bruit and thrill over it. An enlarged bony optic canal shown in the roentgenogram suggested the possibility that the optic nerve in its entire course contained angiomatous vessels. The authors emphasize the necessity for examining the teeth and jaw in the search for an obscure

cause for hematemesis or epistaxis.—*R. S. Bromer.*

#### NECK AND CHEST

THOMAS, A. ROBINSON. A note on the mechanism of deglutition. *Brit. J. Radiol.*, July, 1942, 15, 209-210.

The passage of the bolus of food down the esophagus has usually been attributed to peristalsis and gravity. But Barclay says that the bolus is sucked rather than pushed down. A case is described which seems to support this theory as in it obviously gravity plays no part at all in the act of swallowing. The subject, a man aged thirty-seven, said that he could swallow standing on his head. He was given a drink of opaque medium and told to swallow it while standing on his head. He did so and a roentgenogram, which is reproduced, was taken during the act of swallowing. The bolus rose and passed through the esophagus just as it would have done if he had been standing on his feet. The only factor that could have caused it to rise was suction.—*Audrey G. Morgan.*

CHONT, L. K., and STARRY, L. J. Congenital atresia of the esophagus. *Radiology*. Feb., 1943, 40, 169-174.

Four cases of congenital atresia of the esophagus are reported and illustrated with roentgenograms, 3 from the University Hospital of the University of Oklahoma and 1 from St. Anthony's Hospital of Oklahoma City. This is an unusual condition, only about 350 cases having been reported but a part of the rarity is probably due to lack of diagnosis. Diagnosis should be made more frequently and earlier with roentgen examination.

This anomaly is often associated with others, particularly imperforate anus and atresia of the rectum. In a large percentage of the cases there is a fistula between the esophagus and rectum, as there was in all 4 of the cases here reported.

When the child is first put to the breast the first few swallows are normal while the proximal end of the esophagus is being filled. Then there is violent spasmodic coughing and regurgitation of frothy milk and mucus and rapid onset of cyanosis. Roentgen examination shows the esophagus as a blind sac ending 12 cm. from the central incisors, generally at the level of the fourth dorsal vertebra. If the roentgenogram shows the stomach distended with gas it indicated tracheo-esophageal fistula. Lipiodol should

be used instead of barium for this examination as aspiration of the barium mixture may cause bronchopneumonia. Recently the injection of air has been suggested instead of lipiodol. Treatment is only palliative.—*Audrey G. Morgan.*

KISSIN, MILTON, and COHEN, ABRAHAM G. Large healed tuberculous focus (probably primary) simulating metastatic carcinoma of the lung. *Ann. Int. Med.*, Jan., 1941, 14, 1216-1224.

Case histories with reproductions of roentgenograms of 4 patients are reported. In each case, a rather large dense shadow, due to healed, probably primary, tuberculous focus, was interpreted as due to neoplastic metastasis; proper diagnosis was based on autopsy in one case and on subsequent clinical course in the other three.

The differential diagnostic list in such solitary nodules includes healed tuberculous foci, solitary metastatic lesions, primary pulmonary neoplasms, malignant or benign (chondroma, fibroma and lipoma), and polycythemia vera.—*H. G. Moehring.*

ACKERMAN, LAUREN V., and BRICKER, EUGENE M. Mediastinal emphysema and bilateral pneumothorax following radical dissection of the neck. *Arch. Surg.*, Sept., 1941, 43, 445-450.

An autopsied case of mediastinal emphysema and bilateral pneumothorax is reported in a patient who was subjected to radical dissection of the neck for treatment of cervical metastases from carcinoma of the lip.

Surgical procedures about the neck which open the mediastinum and partially block the upper airways offer a favorable situation for the development of mediastinal emphysema; pneumothorax arises by rupture into pleural space of mediastinal blebs of air. Other mechanisms are: air under increased pressure may break through alveoli and dissect along vascular sheaths to mediastinum; air may pass directly through the wall of any thoracic viscus and infections may permit entry of air into interstitial tissues.

Prevention of this accident during surgery depends on the maintenance of a free airway. Artificial respiration is contraindicated in treatment; treatment consists of aspirating air

by various means from the pleural space. Roentgen examination, especially lateral chest films, verifies the presence of mediastinal air.—*H. G. Moehring.*

PAUL, LESTER W. Diseases of the mediastinum and associated conditions; refresher course. *Radiology*, Jan., 1943, 40, 10-41.

Some five years ago the Radiological Society of North America began the presentation of an annual series of refresher courses, a course of postgraduate instruction in various phases of radiology, covering both theoretical and practical aspects of the subject. This article gives the refresher course on diseases of the mediastinum, covering diseases and tumors of the mediastinal lymph nodes, primary tumors of the mediastinum other than lymph node tumors, mediastinitis, diseases of the thyroid and thymus, diseases of the spine such as tuberculosis and other infections and tumors, cardiovascular lesions that need to be differentiated from other mediastinal masses, such as enlarged left auricle, aneurysm of aorta, right-sided aorta, dilatation of the pulmonary artery and aneurysm of the innominate artery, diseases of the esophagus and stomach, such as cardiospasm, esophageal hiatus hernia and thoracic stomach, and bronchogenic carcinoma. The text is profusely illustrated with diagrams of anatomical conditions in the mediastinum and roentgenograms of the pathological conditions discussed.—*Audrey G. Morgan.*

KORNBLUM, KARL, REIMANN, HOBART A., and PRICE, ALISON H. Atypical pneumonia probably caused by one of the viruses of psittacine group. *Radiology*, Jan., 1943, 40, 75-78.

This clinico-radiological conference was based on the case of a woman of fifty who had a severe shaking chill on December 20, 1941. She came to the hospital on the fifteenth day of the disease with high fever, malaise and cough. The next day a roentgenogram showed a large, dense homogeneous shadow in the lower part of the right upper lobe that suggested lobar pneumonia. There were clinical features that argued against this diagnosis, such as sudden onset in a well subject, failure of sulfadiazine treatment, low leukocyte count, unproductive cough, sweating, recurrent chills, and bradycardia. A diagnosis of virus pneumonia was then made and a complement fixation test for psittacosis apparently confirmed it.

The virus pneumonias most commonly appear in the roentgenogram as an atypical or so-called bronchopneumonia. At the beginning of the disease the shadow may be unilateral but it shows a marked tendency to become bilateral. There is nearly always accentuation of the hilar and trunk shadows, indicating tracheo-bronchitis. There is often diffuse haziness of the lung fields with small mottled areas of increased density scattered through both lungs. Generally the involvement is greater in one lung than in the other. It resembles the so-called influenzal pneumonias of some fifteen or twenty years ago.—*Audrey G. Morgan.*

GORDON, JOSEPH, and TAYLOR, HENRY K.

The post-thoracoplasty roentgenogram, with special reference to posture. *Radiology*, Jan., 1943, 40, 42-48.

In a certain number of cases after thoracoplasty the contour of the regenerated ribs is displaced outward, giving an area of localized lateral convexity. This was seen in 63, or 80 per cent, of 78 postoperative cases in which the sputum remained positive while it was not seen in any of 75 cases successfully operated on in which the sputum remained negative for six months after operation. The authors believe that this lateral convexity overlies an unclosed cavity of aerated lung tissue. Positive pressures have been demonstrated in certain types of tuberculous cavities. Such cavities are extremely resistant to closure by any form of collapse therapy. The usual line of contour of the reforming ribs is displaced, resulting in the lateral convexity.

Post-thoracoplasty roentgenograms often do not give a correct idea of the degree of collapse. After operation there is a variable degree of scoliosis and rotation of the upper thoracic vertebrae with a convexity of the spine toward the operated side. The shoulder girdle on the same side tends to rotate medially. Therefore in order to get a correct posteroanterior roentgenogram for comparison with a preoperative film the patient must be rotated a little so that the shoulder on the operated side is a little way from the cassette. The upper scoliosis may also be corrected by having the patient incline the head toward the shoulder on the operated side. When a localized lateral convexity is seen after operation an especially careful search should be made for bacteria to determine whether there is active disease present.—*Audrey G. Morgan.*

CHESTER, EDWARD M., and KRAUSE, GEORGE R. Lung abscess secondary to aseptic pulmonary infarction. *Radiology*, Dec., 1942, 39, 647-654.

Little has been written about lung abscess secondary to aseptic pulmonary infarct, but it is not extremely unusual. From 1930 to 1939, 344 cases of aseptic pulmonary infarct were seen at the Cleveland General Hospital. In 174 of these cases the infarct was a significant cause of death. This article reports 17 cases of lung abscess following infarct, 11 of which were taken from these 174 cases. The other 6 cases were ones in which the correct diagnosis was made during life.

The signs of infarct are often so masked by those of abscess when the patient is first seen that infarct is not thought of. In any case of lung abscess the possibility of preceding infarct should be considered and a careful search of the history made. The characteristic feature in cases in which abscess develops is the appearance of a foul purulent sputum some days or weeks after the beginning of the infarct. This is generally accompanied by a secondary rise of temperature and an increase in the leukocyte count. If the patient has heart disease it grows worse.

If the case is seen early it is easy to follow up the development of abscess from the infarct by a series of roentgen examinations which should be made in various projections. Eighteen illustrative roentgenograms are given and 4 of the cases described in detail. The roentgenograms vary in appearance depending on size, position, age and the presence of secondary infection, pleural effusion or passive hyperemia. The infarct shadow is generally in the lower part of the lung and in the early stages often sharply demarcated at the medial border. An infarct is always adjacent to a pleural surface either peripheral or interlobar.

Among the 6 cases diagnosed ante-mortem 4 of the patients died in the hospital from the abscess. Two survived the acute illness but died in a few months without recurrence of the infarction.—*Audrey G. Morgan.*

KRAUSE, GEORGE R., and CHESTER, EDWARD M. Infarction of the lung; clinical and roentgenologic study. *Arch. Int. Med.*, June, 1941, 67, 1144-1156.

Of a series of 6,548 autopsies at Cleveland City Hospital, 5.2 per cent showed aseptic

hemorrhagic pulmonary infarcts, and in 2.7 per cent the infarct was a significant cause of death. The source of the thrombus was not found in 54 per cent of the cases.

In 69 per cent of the series the right lower lobe was involved alone or in combination; in 53 per cent the left lower lobe was involved alone or in combination; the remaining lobes were rarely involved alone.

Pulmonary infarct was an important cause of death in 65 per cent of 241 cases with heart disease (regardless of presence of cardiac failure), while in 103 cases without heart disease infarction was significant in only 16 per cent.

Serous pleural effusion, occasionally sero-sanguineous or containing bile pigments, is a common accompaniment of infarction. Hemoptysis, often repeated, with small amounts of bright red blood was the most frequent symptom; next in frequency were pain and an increase in dyspnea. The usual physical signs were of consolidation and pleural effusion; a pleural friction rub was present in some cases. Temperature pulse and respiratory rates increased on the same day infarction occurred. Secondary abscess developed in some infarcts.

The shape of the roentgenographic shadow of the infarct varies with the projection, hence the importance of exposures in more than one position; the density is less than that of lobar pneumonia and it changes little in twenty-four hours. At times only horizontal streaking similar to localized atelectasis is seen. Pleural effusion may obscure infarct, secondary bronchopneumonia, and abscess formation with or without subsequent empyema may alter the appearance. A residual shadow resembling fibrous streaks may persist for years.

The above features, plus thinking of and looking for pulmonary infarction, will be the means of making the diagnosis. Several illustrative case histories and roentgen studies are included.—*H. G. Moehring.*

RHODES, PAUL H., and DURBIN, EDGAR. Coarctation of the aorta in childhood; review of the literature and report of three cases. *Am. J. Dis. Child.*, Dec., 1942, 64, 1073-1096.

The authors' review of the literature on coarctation of the aorta revealed 47 cases in which the adult type had been diagnosed during life in children under fifteen years of age. They regard it of importance to make the diagnosis of coarctation as early in childhood as possible since the life of the patient may be prolonged by prohibiting strenuous sports and occupations. When coarctation of the aorta is pronounced enough to give clinical signs, its diagnosis is not difficult if the condition is kept in mind. It should be suspected when forceful pulsations in the neck and hypertension, particularly with a wide pulse pressure, are observed in a child. The presence of a much lower blood pressure in the lower extremities and of retardation and diminution of pulsation in the femoral arteries confirms the diagnosis. The finding of a collateral circulation and the roentgenologic signs are valuable aids.

Fray considered the most reliable single condition in the roentgenographic diagnosis to be the defect in the aortic arch seen in the left posteroanterior oblique exposure. Rhodes and Durbin have, however, encountered difficulty in outlining the aortic arch in many younger children. In adults with coarctation the aortic knob is absent in the posteroanterior view but this aortic shadow in early life is normally absent or inconspicuous. Hence this sign is not reliable in youth. Hypertrophy of the left ventricle, dilatation of the ascending aorta and erosion of the ribs can be demonstrated in some cases. It evidently requires a period of years for erosion to develop. Erosion if present is considered pathognomonic of the condition, but its absence does not rule out coarctation. In one case reported in the literature, a "double aortic knob" was demonstrated in the posteroanterior roentgenogram. This appeared as a smaller arc inside the usual arc of the aortic knob. It was believed that this second, smaller arc corresponded to the descending aorta below the stricture. Visualization with a contrast medium has been used to localize the coarctation.

If routine determinations of blood pressure in children are made on only one arm, the right arm should be used in order to avoid overlooking the occasional cases of coarctation in which the pressure is low in the left arm. Such a case is reported in this paper with interesting electrocardiographic observations.—*R. S. Bromer.*

#### ABDOMEN

KRAEMER, MANFRED, and TOWNSEND, LESLIE. Chronic gastric ulcer in a six year old child. *Am. J. Digest Dis.*, Oct., 1942, 9, 338-340.

The authors report the case of a six year old



child in whom the roentgenological signs of a gastric ulcer were found.

Clinically, it is of interest that the patient had complained of pains in the left upper quadrant since his fifth year. Most of his pains occurred before or during breakfast. He vomited only once. His appetite was good and there were no other symptoms. There was no abdominal tenderness. There were no signs of bleeding. The roentgen examination revealed that after a teaspoonful of barium was swallowed a niche could be seen in the posterior wall in the body of the stomach. When the stomach was filled with barium the niche could not be demonstrated.

The authors suggest that roentgenological examinations in children should be performed more frequently than usual for ulcers of this kind might otherwise be overlooked.—*Franz J. Lust.*

NEWMAN, ALBERT B. Peptic ulcer in childhood. *Am. J. Dis. Child.*, Oct., 1942, 64, 649-654.

In this article 6 cases of peptic ulcer are reported. Some authors, Newman states, are inclined to emphasize the greater frequency of the disease in children of the low income groups, assuming that dietary deficiency plays a rôle in the causation of the disease. This claim, he thinks, will bear scrutiny because the studies of peptic ulcer have never been conducted on a cross section of the juvenile population but rather have been made on groups of children attending the outpatient clinics of general hospitals. Among children of the high income groups the disease will undoubtedly be found in greater frequency if it is kept in mind as one of the causes of indeterminate abdominal pain and the necessary roentgen studies are made.

The importance of focal infection in the production of peptic ulcer attracts attention by the high incidence of such ulcers associated with acute infectious disease found in the form of acute lesions in routine postmortem examinations following death from such disease. There is no doubt that the demonstrable foci of infection cannot be found in instances of peptic ulceration aside from specific ulcerations, such as those due to tuberculosis or syphilis. The generally accepted opinion is that specific bacterial infection plays little or no part in causing chronic peptic ulcer.

Regarding the general features of peptic ulcers in children, it is the experience of others

that the younger group of children present the greater problem in diagnosis. Newman believes that the diagnosis of peptic ulcer in childhood is basically a roentgenographic diagnosis. The frequency with which diagnosis is made will be directly proportionate to the frequency with which roentgenograms of the gastrointestinal tract are made in suspicious cases. The evidence of the roentgenogram of a child is no different from that of an adult. Borderline situations in interpretation will occur, he states, in which the duodenal bulb may show irritability and irregularity without actual formation of craters. Where such changes persist after administration of atropine, the diagnosis is presumptive. He believes that such patients should receive routine therapy and have periodic roentgen examinations.—*R. S. Bromer.*

EUSTERMAN, GEORGE B. Chronic nonspecific gastritis; significance as a clinical entity. *Gastroenterology*, Jan., 1943, 1, 54-61.

The significance of chronic nonspecific gastritis as a clinical entity awaits final clarification.

Familiar types of gastritis, histologically confirmed, and observed over a period of years, are as follows: phlegmonous gastritis, acute and subacute ulcerative gastritis in association with duodenal and gastric ulcer, hemorrhagic toxic gastritis, chronic atrophic gastritis of pernicious anemia, subacute combined sclerosis, sprue, diffuse atrophic and hypertrophic gastritis secondary to disease of the circulatory, hepatic, pulmonary andcretory systems, primary chronic regional gastritis, and carcinoma simulating hypertrophic antral gastritis, postoperative diffuse and perianastomotic gastritis.

As the result of critical observation and discriminate elimination of all other intrinsic and extrinsic factors no condition other than an inflammatory disease of the gastric mucosa, that is, gastritis, could logically explain certain forms of gastric disorder that are encountered frequently. A gastroscopic examination is indicated in every case of chronic, recurring, otherwise unexplainable dyspepsia.

Simulation of the ulcer symptom complex, or hemorrhage, or both, is a frequent manifestation of hypertrophic erosive or ulcerative gastritis, one of the most important types, clinically speaking. On the other hand, gastritis in its various forms is often symptomless.

The sources of diagnostic error in the presence of gastroscopically verified gastritis are discussed.

Our knowledge of gastritis in its various aspects is still incomplete and problems of practical import awaiting solution are discussed.

Chronic nonspecific gastritis in its various forms is generally conceded to be refractory to treatment, but intensive individualized treatment at the earliest possible moment, as in the case of gastroduodenal ulcer, should lessen our pessimism in this respect.—*Franz J. Lust.*

MARTIN, GUSTAV J., THOMPSON, MARVIN R., and DE CARVAJAL-FORERO, J. The influence of single and multiple B complex deficiencies upon the motility of the gastrointestinal tract. *Am. J. Digest Dis.*, Aug., 1942, 9, 268-273.

The authors studied the influence of single and multiple B complex deficiencies in dogs. From a consideration of the roentgen findings it is the authors' opinion that there are features in common suggesting that the two factors, inositol and pantothenic acid, are both associated with the maintenance of gastrointestinal normality. That other factors, such as pyridoxine, may influence the general picture is illustrated by the hypotonicity in several experiments. The striking similarity of pantothenic acid and inositol deficiencies in their effect on the gastrointestinal tract is to be emphasized and suggests an interdependence of the two factors. The same features characterize the picture if either is absent from the diet. These features are: (1) increased gastric emptying time with pylorospasm; (2) marked segmentation of both the small and the large intestine; (3) general picture of hypertonicity with hypomotility; (4) alternation of ribbon-like segments with dilated loops; (5) frequent formation of gas; (6) fluid levels.

However, these findings and conclusions are in part substantiated by, and in part contradicted by, clinical and experimental data relating to the rôle of the B complex in gastrointestinal function.—*Franz J. Lust.*

HORNCastle, C. WINSOR. Filling-defects with in the barium-filled duodenal cap. *Brit. J. Radiol.*, Nov., 1942, 15, 339-340.

A case is described in which a diagnosis of duodenitis with polyposis was based on the find-

ing of two quite large circular filling defects in the cap of the duodenum. Their mobility was limited, there was generalized coarsening of the mucous membrane relief pattern of the cap, no constant abnormality in the position and shape of the cap which could be caused by external pressure or adhesions, melena and a mild secondary anemia.

The patient was an Indian seaman aged thirty. On waking the next morning the patient vomited and the vomitus contained an almost circular bean about a centimeter in diameter heavily coated with bile pigment. Only one translucency was now visible in the duodenal cap and this subsequently disappeared, evidently from passage of the other bean. The patient had had no beans of this type since six months before when his symptoms had begun. The beans had a very tough outer covering and had evidently lodged in the duodenal cap and caused duodenitis.—*Audrey G. Morgan.*

SUSSMAN, MARCY L., and WACHTEL, EMANUEL. Factors concerned in the abnormal distribution of barium in the small bowel. *Radiology*, Feb., 1943, 40, 128-138.

Certain roentgen abnormalities occur in the small intestine in disease. They include variations in motility and tone, dilatation of loops, abnormal segmentation, coarsening or obliteration of the mucosal folds and flocculation of the barium. This has been called the deficiency pattern and attributed to nutritional deficiency but the author has found it in other diseases, including granulomatous jejuno-ileitis, sprue, and celiac disease. It is evident that inflammation can produce a pattern that cannot be distinguished from the deficiency pattern.

The cause of these changes is not known. It has been assumed that they are due to a defect in the intramural nervous system but the author does not think from the experimental evidence that this is true. They may be produced by edema and infiltration of the submucosa, atrophy of the mucosa, muscle damage and nerve infiltration, modified perhaps by abnormal bowel content and unusual hormonal or nerve stimuli. There is some experimental evidence that the changes can be caused by deficiency of certain vitamin B components but it is not known just what components are lacking. He does not believe that there is any definite proof that these changes all have a common cause.



In the discussion Dr. Golden supported the neurogenic theory of these mucosal changes and said that he thought there must be a common factor in their causation and that it probably lay in the intramural nervous system.—*Audrey G. Morgan.*

FELDMAN, MAURICE. A comparative roentgenologic study of the gallbladder by intensified cholecystography. *Radiology*, Dec., 1942, 39, 697-699.

The routine eighteen to twenty-four hour cholecystographic test with single, double, or triple doses often shows only a faint shadow, or a gallbladder that is faintly outlined or not filled at all. This would indicate a pathological condition but it has been found that such pictures may be caused by other factors, such as defective technique, inadequate preparation of the patient, insufficient dye and overshadowing of the gallbladder by the colon, etc. The author recommends continuing the examination for forty-two to forty-eight hours after the first administration of the dye. If after the routine examination the gallbladder is poorly visible two doses of dye are given, one in the morning and the other in the afternoon. There should be no fat in the diet during the intensified test. At the end of eighteen to twenty-four hours after this second administration of dye a second series of roentgenograms is made, including a left oblique view. If after this second intensified examination the gallbladder is still unfilled or shows only a faint shadow there is probably some pathological condition. But in many cases the gallbladder will fill during the intensified test.

The intensified test was given in a series of 29 cases with doubtful shadows or no shadows at all. After the prolonged test 13 of these cases showed normal findings and 16 abnormal findings, which proves the great value of the intensified test.—*Audrey G. Morgan.*

FELDMAN, MAURICE, GOODMAN, JEROME E., and WEINBERG, TOBIAS. Varices of the gall bladder associated with a mucosal cyst. *Am. J. Digest. Dis.*, Dec., 1942, 9, 399-400.

The authors report a case in which varices of the gallbladder were found. Cholecystography revealed an enlarged gallbladder shadow, of good but uneven density. There were two shallow defects close to the neck of the gallbladder

which suggested the presence of neoplasms. In the fundus there was a punched out defect about 1 cm. in diameter. The gallbladder contracted following a fat meal. There was no sign of stones. The cholecystographic findings were interpreted as representing benign neoplasms.

At operation a curious and bizarre appearance of the gallbladder was observed. It was crisscrossed by dilated, tortuous, engorged veins which arose in the serosa. Another group of unusually prominent veins were noted hanging loosely from the liver bed like a bunch of grapes, spreading over the gallbladder. The cystic vein was markedly dilated. When the cystic vein was clamped, the dilated veins of the gallbladder collapsed, while those originating in the liver bed remained dilated. The liver was enlarged, extending about four finger-breadths below the costal margin.

The gross appearance of the gallbladder showed the serosal surface wrinkled and glossy. The wall was of average thickness. The fundus showed a small mucosal cyst, measuring approximately 1 cm. in diameter. It appeared to be superficial, lying wholly within the mucosa and contained a brownish, pink-staining granular material. Within the subserosal tissues adjacent to the cyst were several enlarged veins. The remaining mucosal surface was normal. Microscopic study of the gallbladder wall showed diffusely scattered lymphocytes and polymorphonuclears. The mucosa was intact and heaped up into folds. The cyst was lined with normal mucous membrane.

The two groups of veins, the cholecystic and hepatocholecystic veins were well demonstrated in this case. The portal system was apparently not involved as there were no varicosities elsewhere.

The etiology of mucosal cyst of the gallbladder is unknown. It is believed that they originate in Luschka's ducts.—*Franz J. Lust.*

HURWITT, ELLIOTT S., and ARNHEIM, ERNEST E. Meconium ileus associated with stenosis of the pancreatic ducts; clinical, pathologic and embryologic study. *Am. J. Dis. Child.*, Sept., 1942, 64, 443-454.

The association of inspissation of meconium in the newborn resulting in obstruction of the intestine (meconium ileus) and cystic fibrosis of the pancreas was first reported by Landsteiner in 1900. The authors report a case of meconium ileus associated with stenosis of the main pan-

creatic duct and cystic fibrosis of the pancreas including histologic study of the pancreas by serial sections. They state that investigation of early embryos reveals that the pancreatic ducts, in contrast with the biliary ducts and the duodenum do not pass through a stage of occlusion by epithelial proliferation. The cause of congenital stenosis of the pancreatic ducts is a focal developmental defect. They state also that the basic lesion in meconium ileus is assumed to be interference with the passage of pancreatic enzymes into the duodenum. Farber has suggested that the inspissated meconium might be washed from the bowel by way of an enterostomy or colostomy, pancreatic extracts or duodenal juice being used as solvents. This suggestion seems to the authors to be of value in the therapy of this uniformly fatal condition, since death is due to mechanical blockade of the intestinal lumen.

The case reported is that of a boy, aged twenty-four hours, with the history of absence of passage of meconium per rectum since birth and intermittent regurgitation of bile-stained fluid for twelve hours. A roentgenogram of the abdomen, without use of a contrast medium, showed pronounced distention of the loops of the jejunum.—*R. S. Bromer.*

SOLIS-COHEN, LEON, and LEVINE, SAMUEL.  
Roentgen diagnosis of lacerated spleen.  
*Radiology*, Dec., 1942, 39, 707-710.

Under war conditions roentgenograms of the abdomen should be examined carefully for evidence of injury to the spleen or liver as bomb injuries may cause rupture of internal organs without external evidence.

The clinical symptoms of lacerated spleen are those of intra-abdominal hemorrhage. This may be violent and cause early death, it may be progressive, allowing the patient to walk some distance but becoming manifest within forty-eight hours or it may be delayed with repeated bleeding at intervals of several days. Delayed splenic hemorrhage must be recognized promptly if the patient is to be saved.

Normally the shadow of the spleen can be seen on the roentgenogram in the left upper quadrant. In laceration of the spleen this shadow is obliterated. The blood also gravitates along the gastrosplenic ligament and infiltrates along the wall of the stomach, resulting in a jagged, serrated greater curvature. The extent

of serration and deformity of the curvature is in direct proportion to the severity of the hemorrhage. If the hemorrhage is severe there may be an associated reflex dilatation of the stomach. These two signs are of great value in the diagnosis of lacerated spleen and in some cases perisplenic bleeding also causes tenting of the diaphragm which is an additional significant sign.

Three cases of roentgen diagnosis of lacerated spleen are described and illustrated with roentgenograms.—*Audrey G. Morgan.*

#### GYNECOLOGY AND OBSTETRICS

GRABER, E. A., and KANTOR, H. I. Direct measurement of Caldwell-Moloy x-ray plates.  
*Am. J. Obst. & Gynec.*, Jan., 1943, 45, 112-116.

Some obstetricians study only architecture and consider measuring the pelvis unnecessary. The authors believe that measurements present additional information especially important in the borderline pelvis. If the obstetric conjugate, for example, is less than 9 cm., a difficult delivery may be anticipated even in a true gynecoid pelvis. The number of borderline pelvises is comparatively large.

As many find it difficult to measure accurately the planes of the pelvis through a stereoscope, the authors sought a method to act as a check. This entails the routine method of taking Caldwell-Moloy roentgenograms. The only additional equipment needed is a metallic ruler which is placed between the patient's buttocks when the lateral plate is taken. The measurements of all midline diameters directly on a ruler placed in the midline is obvious. Determination of transverse measurements is based on the geometric theorem, "in similar triangles, the bases bear the same relationship to each other as the altitudes."—*Mary Frances Vastine.*

COPLAND, SIDNEY M., and COLVIN, S. H., JR.  
The Krukenberg tumor; critique, with report of additional four cases, including the smallest on record. *Am. J. Obst. & Gynec.*, Jan., 1943, 45, 59-69.

Four cases of Krukenberg tumor are reported and the following conclusions are reached:

(1) The Krukenberg tumor is a primary or secondary tumor of the ovary. It is of epithelial

origin and is usually bilateral. Ascites is frequently an accompaniment.

(2) A primary Krukenberg tumor of the ovary is rare and can only be classified as such after microscopic examination of the various viscera (especially the stomach) from which it may metastasize.

(3) The typical cell in the Krukenberg tumor is the signet ring cell.

(4) The mode of metastases is most probably through the lymphatics or blood stream.

(5) The ovaries should be examined before the surgeon classifies an intestinal tract malignancy as non-metastatic.

(6) The incidence of the Krukenberg tumor seems to be increasing.

(7) The primary growth need not possess the same structure as the Krukenberg metastases in the ovary.—*Mary Frances Vastine.*

#### GENITOURINARY SYSTEM

BEILIN, L. M., and NEIMAN, B. H. Bilateral renal carcinoma. *J. Urol.*, Dec., 1942, 48, 575-584.

Although bilateral Wilms tumor is not infrequent in children, bilateral primary renal carcinoma in adults is rare. The authors found 8 cases reported in the literature and added a ninth case in a fifty year old male who was admitted with complaints of hematuria and left loin pain of one week's duration. The left kidney was palpable and enlargement was revealed on the flat roentgenogram. Bilateral retrograde pyelography showed a coarse pattern of the left kidney calyces and a suggestive tumor mass in the lower pole of the right kidney. The possibility of bilateral cystic disease or neoplasm was suggested. Following recurrent attacks of hematuria and left loin pain a left nephrectomy was performed and the diagnosis of hypernephroma made.

The patient gained weight and became symptom free following operation. Six and a half years later he was again seen complaining of hematuria of one year's duration, pain in the right loin and loss of weight and appetite. A survey roentgenogram showed enlargement of the right kidney. Retrograde pyelography showed a distorted compressed kidney pelvis and a single flattened calyx, the ureter was displaced medially. The patient's clinical course became progressively worse. Autopsy revealed

hypernephroma of the right kidney.

The following arguments are offered by the authors in favor of primary malignancies in each kidney rather than the lesion in one kidney being metastatic from the other: (1) no other evidence of metastasis was found; (2) direct metastasis from one kidney tumor to the other kidney is exceedingly rare, and (3) slowness of progression of the tumors which would make bone and lung metastases probable if any metastasis occurred. It is obviously impossible to be certain that one lesion was not metastatic from the other.—*R. M. Harvey.*

VITT, A. E., and MELICK, W. F. Carcinoma of the kidney and pregnancy. *J. Urol.*, Dec., 1942, 48, 601-610.

The occurrence of renal tumors in pregnancy is rare. The relatively young age, however, of pregnant women is probably the responsible factor. The authors found in the literature 6 cases of hypernephroma of the kidney associated with pregnancy. They summarized the reports of these 6 cases and added an additional case. This occurred in a twenty-one year old white woman who had an uneventful pregnancy and post-natal course except for a transient fever which was accompanied by pain in the lumbar area and slight burning on urination. Approximately three months after discharge from the hospital the patient returned complaining of hematuria of five days' duration and left lumbar pain. A retrograde pyelogram disclosed a filling defect in the left kidney which obliterated the middle and lower calyces. Survey roentgenograms of the skeleton were negative. A nephrectomy was performed and the diagnosis of papillary adenocarcinoma was made. Postoperative irradiation was given. A subsequent pregnancy resulted in a living child sixteen months postoperatively. At this time the patient was in good health; a pyelogram of the right side was normal and there was no evidence of metastasis.

Although pregnancy is generally considered to affect adversely malignant tumors of the genital tract none of the 8 cases of renal tumor reviewed by the authors appeared to be so affected. In no case was pregnancy influenced by nephrectomy. Further pregnancies do not appear to be contraindicated providing a close watch is kept on the condition of the remaining kidney.—*R. M. Harvey.*

FOWLER, H. A. Papillary carcinoma of the right kidney; report of a case with atypical history and findings. *J. Urol.*, Dec., 1942, 48, 563-570.

This case is reported by the author because of the difficulties presented in diagnosis. The case is that of a sixty year old female who had had complaint referable to the gastrointestinal tract for three years; she had lost approximately 50 pounds in weight. Roentgen study of the gastrointestinal tract showed a ptotic stomach and a spastic colon. Because of tremor, elevated pulse rate and a plus 30 basal metabolic rate, roentgen treatment was given to the thyroid gland. The patient gained 50 pounds in the next two years but was never relieved of the gastrointestinal complaints, alternating diarrhea and constipation, bloating after meals, flatulence, anorexia and "bilious spells." At the end of this two year period the patient began to experience dizziness, weight loss and loss of appetite. At this time she first began to complain of pain in the right lower quadrant radiating toward the right kidney. Abdominal examination showed enlargement of the right kidney. Intravenous urography showed a normal left kidney and a non-functioning right kidney. Cystoscopic examination revealed an impassable obstruction of the right ureter, and an attempted right retrograde pyelogram showed an irregular collection of medium in the soft tissues lateral to the tip of the catheter. The interpretation of the author was a peri-ureteral abscess communicating with the ureter. A film exposed three hours later showed the dye to have drained from the abscess cavity into the bladder. The pyelographic diagnoses were non-functioning right kidney, complete stricture of the right ureter and peri-ureteral abscess communicating with the right ureter. Operations disclosed a right kidney which consisted mainly of scar tissue and two old abscess cavities. Histopathological report was papillary carcinoma. Multiple metastases occurred prior to death.

The interesting features of this case were predominance of gastrointestinal symptoms, absence of the genitourinary symptoms in the presence of advanced malignancy plus secondary infection, and the bizarre appearance of the pyelogram which revealed the presence of kidney disease but provided no specific diagnosis.—*R. M. Harvey.*

ATKINSON, R. C. Skin metastases from bladder tumors. *J. Urol.*, Oct., 1942, 48, 350-356.

According to Ewing, extension from bladder tumors is usually through the bladder wall to the pelvic tissues, up the ureters to the kidneys, or along the lymphatics to the prevertebral lymph nodes. Blood-borne metastases to the skin are very rare. The author found 4 such cases reported in the literature.

Thirty-six primary bladder carcinomas were found by the author in a series of 1,000 autopsies at Stanford University on patients dying of carcinoma. One had skin metastases. This was in a fifty-nine year old man who had had gross hematuria for four days. Prior to that he had had occasional bouts of hematuria for three years. Excretory urography showed a large filling defect in the bladder; the kidneys and ureter appeared normal. Cystographic examination showed a large ulcerating mass in the left lateral wall of the bladder. This was fulgurated and four 25 mg. radium bombs were placed in contact with the base of the lesion for fourteen hours. The pathological specimen was at first reported as a papilloma of the bladder but on subsequent examinations the diagnosis of papillary carcinoma was made.

Six weeks postoperative a metastatic lesion appeared on the upper lip. The patient died two months later with multiple skin metastases. No metastases could be demonstrated roentgenologically in the chest or bones.—*R. M. Harvey.*

McCAHEY, J. F., and FETTER, J. S. Intravenous urography during renal pain from ureteral stricture. *J. Urol.*, Dec., 1942, 48, 622-627.

Urography is not considered of value in the diagnosis of ureteral stricture. The authors feel that some value may be obtained from intravenous urography in cases of ureteral stricture if the examination is performed when the patient is experiencing renal pain. They cite 2 cases to substantiate this belief. The first case was a thirty-eight year old male on whom a retrograde pyelogram showed a moderate unilateral hydronephrosis and hydroureter. Although the left ureteral meatus was edematous at cystoscopy no stone could be found. An intravenous pyelogram done several days later during an attack of renal pain showed opacification of the affected kidney on the five minute roentgenogram without evidence of dye in the

kidney pelvis. The fifteen and thirty minute roentgenograms showed an outline of the entire urinary tract on the affected side. At operation no stone could be found. The second case was that of a thirty-five year old white female who had had recurrent attacks of left renal pain. The intravenous pyelograms were normal except for slight dilatation of the lower third of the left ureter and a suggestive smaller calculus near the mouth of the left ureter. Roentgenograms taken with an opaque catheter in the left ureter showed the catheter to lie in close relationship with what had been thought to be ureteral calculus. An intravenous urogram was done two days later during an acute attack of pain. This showed a functioning kidney on the right but no visualization of dye on the left on the five minute film. On the fifteen minute film there was an opacification of the left kidney and on the thirty minute film the left urinary tract was completely outlined and showed moderate dilatation. The distal end of the left ureter was suggestive of stricture. The authors postulate that the delayed appearance of the dye in excretory urogram during periods of renal colic is due to the fact that the ureter and kidney pelvis on the affected side are filled with urine.—*R. M. Harvey.*

#### NERVOUS SYSTEM

LOWMAN, ROBERT M., and FINKELSTEIN, ARTHUR. Air myelography for demonstration of the cervical spinal cord. *Radiology*, Dec., 1942, 39, 700-706.

Lipiodol examination of the cervical cord has not proved very successful because of escape of the opaque material into the cranial subarachnoid pathways. But it has been found that air myelography of this part of the cord is very successful. Air could be demonstrated in the cervical part of the spinal canal in all of 50 unselected encephalograms. Air is injected in the lumbar region with the patient standing and is retained in the cervical canal because of partial obstruction at the level of the axis thought to be due to downward projection of the cerebellar tonsils through the foramen magnum which blocks the upward passage of the air.

Roentgen examination following the introduction of air is made in the lateral projection by Caldwell's method. With the patient standing the lateral aspect of the shoulder is pressed against the cassette changer or cassette. The

head is fixed so that the median plane of the face is vertical and parallel to the plane of the film. The fourth cervical vertebra is opposite the center of the cassette and the central ray is projected through this point. The technical factors for the average patient with a neck 8 cm. thick are: 75 kv., 50 ma., anode-film distance 72 inches. A high speed Potter-Bucky diaphragm is used. The five upper segments are shown clearly but because detail may be obscured by the muscles of the neck in the sixth and seventh segments modified oblique views may be necessary for this region.

Diagrams and roentgenograms are given showing the individual variations in the curvature and position of this part of the cord. Three cases are described in which tumors of the cervical cord were demonstrated by this method.—*Audrey G. Morgan.*

#### SKELETAL SYSTEM

FRANKLIN, EMILY L., and MATHESON, I. Melorheostosis; report on a case with a review of the literature. *Brit. J. Radiol.*, July, 1942, 15, 185-191.

Melorheostosis is a rare bone condition first described in 1922 by Léri and Joanny. The authors have found 38 cases reported in the literature since that time which are briefly reviewed and they describe a case of their own in a woman of forty-one admitted to hospital on account of an ulcer of the back of the right foot. Since the age of about ten her left leg had been shorter than the right. For the past two or three years she had had extreme edema of the right leg, which was greatly enlarged and there were recurrent ulcerations on the back of the right foot. The changes characteristic of the disease were found in a large number of bones on the right side of the body and none on the left except the fifth lumbar vertebra. Both upper and lower limbs were involved, which is unusual.

In melorheostosis there is hyperostosis of the bones generally confined to either the lateral or medial side of the involved bone. It looks like molten wax flowing down the side of a candle. Roentgenograms showing the appearance are given. The microscopic appearance differs depending on the stage of the disease in which the specimens are taken. No satisfactory explanation has been found of the cause of the disease.—*Audrey G. Morgan.*

SAUER, H. R. Case of large bone metastasis from carcinoma of the ureter complicated by congenital giant hydronephrosis. *J. Urol.*, Nov., 1942, 48, 467-473.

The author estimates that at least 189 cases of primary cancer of the ureter have been published. He reports the case of one fifty-six year old man who was admitted with complaints of intermittent right lumbar pain of two years' duration, presence of a tumor mass in the right upper abdomen for two weeks, right shoulder joint pain which had been increasing in severity for the past six weeks and three attacks of transient hematuria during the previous years. Physical examination disclosed swelling, tenderness and limitation of motion of the right shoulder girdle and the presence of a large tumor mass in the right upper abdomen. At cystoscopy no dye was recovered from either ureter following phthalein injections. Retrograde pyelogram showed no dye in either kidney but an irregular accumulation in the lower portion of both ureters. A film one hour after injection showed a normal double leftsided kidney but no dye in the right kidney. An excretory urogram three days later showed a non-functioning left kidney and moderate dilatation of the left lower kidney pelvis. A roentgenogram of the right shoulder girdle showed a large destructive lesion of the head and upper shaft of the right humerus. Autopsy showed a primary carcinoma of the middle third of the right ureter which had metastasized to the right humerus and to the left kidney. A reduplicated kidney pelvis and ureter was found on the left side. A massive hydronephrosis due to congenital ureteropelvic stricture was found on the right side. The middle third of the right ureter was filled with a papillary tumor which was distinct from the stricture previously mentioned. The hydronephrosis in this case was secondary to the stricture and not to the tumor. The metastatic lesion in the right humerus secondary to ureteral tumor is a clinical rarity.—*R. M. Harvey.*

TRUOG, C. P. Bone lesions in acquired syphilis. *Radiology*, Jan., 1943, 40, 1-9.

The bone lesions of syphilis may imitate those of almost any other bone disease. The difficulties of differential diagnosis are illustrated by 9 cases described in this article, 8 of which are illustrated with roentgenograms. The

author concludes that all cases of bone syphilis are osteomyelitis and that gumma is merely a type of syphilitic osteomyelitis in which necrosis is the outstanding finding. It should be possible by a very careful study of roentgenograms to make a differential diagnosis between syphilitic and other forms of bone disease.

The first case here described was in a Negro who attributed the pain in his shin bone to an injury. Roentgen and laboratory examinations showed a syphilitic condition in which the periosteum was chiefly involved though there was probably a low grade osteitis as well. In the second case a diagnosis of probable osteogenic sarcoma was made but a more careful study would have shown that what was thought to be transverse spicules was merely an irregularity in the periosteal proliferation. In the third case the findings were not characteristic of any form of bone tumor but the possibility of syphilitic osteomyelitis was not considered and a diagnosis of osteochondroma was made. The fourth case was one of generalized bone syphilis which resembled generalized osteolytic metastases. The fifth case was one of syphilis of the right clavicle with a draining sinus which cleared up on antisyphilitic treatment. The Kahn test was negative but it frequently is after insufficient antisyphilitic treatment. Case 6 was one of multiple osteomyelitis showing the variety of roentgen manifestations of the disease. In Case 7 microscopic examination was not satisfactory because there were no blood vessels in the specimen. It is hard to make a definite diagnosis of syphilitic osteomyelitis without perivascular lymphocyte infiltration. The eighth case was one of destructive syphilis of the clavicle which resembled metastasis but this diagnosis was ruled out by the clinical findings. Case 9 also showed the variable roentgen findings in syphilitic osteomyelitis. It resembled a generalized metastasis but the findings were not characteristic of any special form of tumor and the correct diagnosis was finally made from the roentgenograms.—*Audrey G. Morgan.*

SULLIVAN, T. J., GUTMAN, E. B., and GUTMAN, A. B. Theory and application of the serum "acid" phosphatase determination in metastasizing prostatic carcinoma; early effects of castration. *J. Urol.*, Oct., 1942, 48, 426-458.

Kutscher and Wolbergs, in 1935, discovered that normal human prostatic tissue is rich in an "acid" phosphatase. This enzyme appears to be



elaborated by the prostatic glandular epithelium. It does not appear in significant concentration until puberty. Its appearance indicates physiological maturity of the glandular epithelium. The enzyme is excreted in the prostatic fluid. Its exact physiological rôle in the semen is unknown.

Gutman, Scoul and Gutman noted in 1936 that metastatic tumor cells from prostatic cancer retained their capacity to elaborate phosphatase. They found that the serum of patients with metastatic prostatic cancer contained "acid" phosphatase which was indistinguishable from prostatic tissue "acid" phosphatase. A normal value for serum "acid" phosphatase was determined to be 2.5 units of activity per 100 cc. of serum according to the authors' method of determination. Fresh non-hemolyzed sera must be used. Serum "acid" phosphatase levels were found to be elevated in other diseases, such as breast cancer in females, Paget's disease, hyperparathyroidism and osteopetrosis. The authors concluded that values above 4.5 units per 100 cc. of serum were indicative of metastasizing prostatic carcinoma and values below 3 units per 100 cc. were negative. Values between these two levels were of indeterminate significance. They used a modification of the King-Armstrong method for the determination of alkaline phosphatase to determine the serum "acid" phosphatase activity. Their unit is defined as "that degree of phosphatase activity which at pH 4.9 and 37° C. will liberate from the specified citrate buffer-monophenylphosphate substrate solution —mg. of phenol in one hour."

In order to evaluate the reliability of elevated serum "acid" phosphatase determinations as a criteria of metastatic prostatic carcinoma, the authors examined 285 patients with prostatic disease and 600 control cases. One hundred per cent of 30 normal cases showed "acid" phosphatase levels below 3 units; 15 per cent of 130 cases of prostatic carcinoma with roentgen evidence of bone metastases had levels below 3 units, and 50 per cent had levels above 10 units. The authors suggest as possible reasons for the low values in the 15 per cent of cases mentioned the following factors: (1) failure of neoplastic prostatic tissue to elaborate "acid" phosphatase which may in turn be due to immaturity of cells; (2) insufficient extension of the malignancy; (3) erroneous diagnoses, and (4) previous treatment such as castration, irradiation or

estrogenic therapy which depresses the "acid" phosphatase level.

Eighty-nine per cent of 70 cases of prostatic cancer without roentgen evidence of bone metastases had "acid" phosphatase level of less than 3 units and the remaining 11 per cent levels below 5 units. The authors suggest that metastases may already be present in some of the 11 per cent of cases who had values between 3 and 5 units, although such metastases were not demonstrable roentgenologically. Adequate follow-ups might have demonstrated metastases in some of these cases.

One hundred per cent of 85 cases of benign prostatic hypertrophy and prostatitis had serum "acid" phosphatase levels within normal limits.

Occasional moderate elevations of the serum "acid" phosphatase were encountered in bone metastases from malignancies other than those of the prostate. Eighty-one per cent of 99 such cases had normal values and the remaining 19 per cent had values ranging from 3 to 10 units. The highest values were obtained in patients with bone metastases from carcinoma of the female breast. Ninety per cent of primary bone tumors in a series of 31 cases had normal "acid" phosphatase values; in the remaining 10 per cent values ranged from 3 to 5 units.

Of most interest to radiologists were the findings in Paget's disease which is the disease most apt to be confused with metastatic prostatic cancer. In 96 cases of Paget's disease 79 per cent had normal "acid" phosphatase values, 18 per cent had values from 3 to 5 units and 3 per cent from 5 to 10 units. In the cases with high "acid" phosphatase values the serum "alkaline" phosphatase values were also elevated which helps to differentiate between this disease and metastatic prostatic carcinoma.

In 9 cases of hyperparathyroidism two-thirds showed normal phosphatase levels. The remaining 3 cases had unit values of 4.3, 5.0 and 5.1. These values returned to normal following removal of the parathyroid tumors.

The authors found the following practical applications of serum "acid" phosphatase determination: (1) corroboration of the diagnosis of metastasizing prostatic carcinoma in patients with roentgen evidence where castration is contemplated and medical legal problems may arise; (2) provision of chemical evidence for or against metastases of a prostatic tumor when the roentgen evidence is inconclusive; (3) to determine the site of the primary tumor in

cases with roentgen evidence of metastases and no demonstrable primary tumor; (4) differentiation between Paget's disease and metastatic prostatic carcinoma; (5) selection of the type of therapy to be employed in patients with prostatic carcinoma, enucleation being done in the presence of a normal "acid" phosphatase and bilateral orchidectomy being done in cases with high serum "acid" phosphatase; (6) in the detection of metastases of recurrent tumors following prostatectomy, and (7) in selection of patients for treatment by estrogenic therapy and in evaluation of the results of such therapy.

Huggins and Hodges, in 1941, demonstrated the prompt reduction of serum "acid" phosphatase levels in metastatic prostatic carcinoma following estrogenic therapy for castration. This reduction was accompanied in many cases by remarkable clinical symptomatic improvement. The authors confirm the findings of Huggins and Hodges in 33 patients with prostatic carcinoma in whom castration was performed.

The conclusion reached from this study is that serum "acid" phosphatase values are consistent and specific enough to be reliable, although not of infallible diagnostic aid to the clinical and roentgenologic diagnosis of metastatic prostatic carcinoma.—*R. M. Harvey.*

BRAILSFORD, JAMES F. The skeleton at birth. *Brit. J. Radiol.*, Aug., 1942, 15, 213-223.

A detailed description is given of the centers of ossification of the fetus at birth. Premature infants show decreased ossification corresponding to their lack of maturity. Major defects in the development of the fetal skeleton and evidence of certain bone dystrophies may be seen on the roentgenogram. A table is given showing the time in pregnancy when the various bones become ossified sufficiently so that they show on the roentgenogram. The bones of the skull, spine and limbs can be seen at the end of the second month of pregnancy if the uterine shadow is projected free of the pelvic bones and the shadows of the contents of the colon and rectum. Usually by the fifth month the fetal skeleton is clearly visible. Death of the fetus may occur at any time and if it dies the bones of the skull overlap.

Various abnormal conditions of the fetal skeleton are described and roentgenograms given of the skeleton of the normal full-term fetus and of various abnormalities, including osteogenesis imperfecta, in which the details of the fetal

skeleton cannot be seen clearly even at term, fetus papyraceous, anencephalus, localized and complete myelocoele and hydrocephalus.—*Audrey G. Morgan.*

BRAILSFORD, JAMES F. Chronic sub-periosteal abscess. *Brit. J. Radiol.*, Nov., 1942, 15, 313-317.

Chronic subperiosteal abscesses are not so common as chronic central bone abscesses. The characteristic clinical signs are attacks of pain, varying in severity without localized heat, redness or swelling. If the bone is near the surface there may be swelling but the skin over it is not changed. The roentgenogram shows a localized lesion beneath the periosteum with a periosteal reaction for 2 or more inches up and down the bone. These abscesses occur chiefly in long bones. New periosteal bone is formed which at first is less dense than the normal cortex but gradually the latter seems to be absorbed into the new tissue which becomes dense till there is no line of demarcation between the normal and new bone. In small bones the reaction may extend entirely around the bone, while in larger ones it extends only part of the way. The bone may be twice as large as normal. Resection of the involved part of the cortex usually brings about healing.

Jaffe and Lichtenstein have described such lesions as osteoid-osteomas but there is no known benign tumor of bone that produces reaction distal to the wall of the tumor.

Six cases are described and illustrated with roentgenograms. One of the patients was a congenital syphilitic and the lesion was thought to be a gumma. It did improve to some degree under antisiphilitic treatment. In 1 case a pure culture of *Bacillus typhosus* was obtained and in 3 cases staphylococci were cultivated from the central bone.—*Audrey G. Morgan.*

ZIMMERMANN, CARL A. W. Osteopetrosis (Albers-Schönberg disease), with case report. *Radiology*, Feb., 1943, 40, 155-162.

The case of osteopetrosis described is said to be the 120th case reported. The patient was a boy of nine who complained that his face was crooked. He had had a large head at birth. He was much smaller than a friend of the same age and was totally deaf on the left side. His intelligence was normal. Roentgen examination showed the typical abnormal density of bone throughout the skeleton. In the skull there was



no evidence of pneumatization of the sinuses. There were no fractures though pathological fractures are frequent in this disease. The nasal bones were so thick that the respiratory lumen was obstructed and caused post-nasal clearing noises which probably led to the two adenoid operations to which the boy had been subjected.

The cause of the unbridled calcium metabolism in this disease is not known. Blood chemistry studies show no characteristic abnormality. Death is usually caused by hydrocephalus, complications following bone injuries or intercurrent disease. Few of the patients have reached an advanced age and there is no effective treatment. The frequent anemia is due to encroachment of the calcium on the bone marrow. The thickened skull bones exert pressure on the structures inside the skull which may cause hebetude, hydrocephalus, headache, vomiting or paralysis of cranial nerves, resulting in blindness, facial palsy or deafness.—*Audrey G. Morgan.*

BICKEL, WILLIAM H., GHORMLEY, RALPH K., and CAMP, JOHN D. Osteogenesis imperfecta. *Radiology*, Feb., 1943, 40, 145-154.

The authors discuss 40 cases of osteogenesis imperfecta seen at the Mayo Clinic. Eleven were of the hereditary type and the balance of the non-hereditary congenital type. The characteristic features of this disease are brittle bones, blue sclera and osteosclerosis. The cause is not known but it is probably some defect in the germ plasm. There were multiple fractures in all of these cases but one. Deafness occurred in 45.4 per cent of the hereditary type and 17.3 per cent of the non-hereditary type.

The skull usually showed a typical roentgen picture with thin cortex and only islands of dense bone. There were many wormian bodies, especially around the lambdoid and coronal sutures. In the spinal column there was softening of the vertebrae with flattening and wedging of the bodies and ballooning of the intervertebral discs. The long bones showed a thin porotic cortex and enlarged marrow cavity. The shafts

were generally bowed. Small long bones such as the fibulae and ribs sometimes appeared in the roentgenogram as mere wisps of bone. In 7 cases of the hereditary type the roentgen findings were not typical. The bones were normal or only slightly porotic. These patients were aged thirty-two to fifty-four years.

There is no known specific treatment for the disease. Subcutaneous injections of thymic extract were given in 6 of these cases without marked effect.—*Audrey G. Morgan.*

JOHNSTONE, A. S. A case of osteochondritis in the sesamoid of the second metatarsal. *Brit. J. Radiol.*, Nov., 1942, 15, 337-338.

The author believes that no case of osteochondritis in the sesamoid of the second metatarsal has ever been described before. The patient was a hospital sister thirty-two years of age who complained of slight pain and tenderness of the sole of the right forefoot, aggravated by standing and relieved by rest. There was localized tenderness over the plantar surface of the second metatarsal. A roentgenogram April 22, 1940, showed some flattening of the sesamoid bone. There was a dense area in the center surrounded by a translucent ring. Outside this the edges were irregular and beginning to show fragmentation. The corresponding sesamoid in the left foot was abnormally but uniformly dense. Roentgenograms in May and July of the same year showed the fragments more clearly defined and the translucent areas around them wider. Treatment consisted of wearing a pressure pad. Roentgenograms in February, 1942, showed reconstruction of bone in the affected sesamoid. The bone now showed uniform density. The appearance of the left sesamoid was unchanged. The diagnosis was confirmed by the restoration of bone structure after passing through the various stages of osteochondritis. The unchanged appearance of the left sesamoid for two years argues against avascular necrosis as the cause of this case. It was probably caused by slight, frequently repeated trauma.—*Audrey G. Morgan.*



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## THE ROENTGENOGRAPHIC DIAGNOSIS OF THE SMALL CENTRAL PROTRUDED INTER- VERTEBRAL DISC

INCLUDING A DISCUSSION OF THE USE OF PANTOPAQUE AS A  
MYELOGRAPHIC MEDIUM

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### INTRODUCTION

THE characteristic lateral defect in the myelogram produced by the usual disc protrusion has become familiar through the studies of Hampton and Robinson,<sup>5</sup> Bradford and Spurling,<sup>1</sup> and others. There is a small group of patients with disc protrusions in which this defect is not found during the course of the usual myelographic examination.

It is the purpose of this report to describe the myelographic appearance in 5 such cases in which a small central protruded intervertebral disc was found at operation.

Eck,<sup>3</sup> in describing the location of disc protrusions, says: "Less commonly it (the protrusion) may occur centrally with symptoms of partial cord compression in the more severe cases, but with only moderate soreness in the milder cases. At some time following central rupture, however, the protruding material may migrate laterally with ensuing typical nerve root symptoms." Bradford and Spurling<sup>1</sup> state: "A midline defect is unusual," and "The diagnosis of midline herniations is largely a roentgenographic problem because in such cases the symptoms are chiefly limited to

the back without the characteristic radicular findings." Horwitz<sup>6</sup> expressed doubt as to "whether such a minimal lesion (a small central disc protrusion) would be productive of sufficient symptoms and signs to warrant exploration."

### TECHNIQUE

The practice of the Neurosurgical Section at this hospital has been to request a myelographic examination in every case of suspected protruded intervertebral disc where the lesion has been incident to Army service.

The patient is placed in the lateral recumbent position with his head towards the head end of the roentgenographic-roentgenoscopic tilt table. Care is taken, as with the usual lumbar puncture in this position, to see that both shoulders are in the same vertical plane, and that the head, trunk and knees are well flexed.

After preparing the skin, the subcutaneous tissues down to the interspinous ligaments are injected with novocain solution at the site of puncture, usually the third, but occasionally the second, lumbar interspace. On obtaining a free flow of spinal

fluid, the contents of one ampule of pantopaque, 3 cc., is injected firmly and steadily. If the injection is done hesitantly and intermittently, the opaque fluid may break up into globules.

The stilet of the lumbar puncture needle is then replaced, and the patient cautioned to turn over slowly so that he will lie flat on his abdomen. He is then moved so that the soles of his feet are placed firmly against the foot rest of the tilt table.

This procedure usually leaves a homogeneous column of pantopaque at the level of the third lumbar vertebra. The table is then tilted so that the opaque fluid descends the spinal canal slowly; the advancing margin of the column is watched for slight deformities until the third lumbar interspace is bridged. If slight persisting deformities are observed, "spot" roentgenograms are made to show various degrees of development of the deformity. The table is tilted still further, and the fourth and fifth (lumbosacral) discs and the cul-de-sac are investigated roentgenoscopically and "spot" roentgenograms are made. The column is then allowed to ascend the lumbar spine as the table is tilted towards the horizontal and the advancing edge is observed carefully for slight deformities. The last three interspaces are then roentgenoscoped in each oblique and "spot" roentgenograms made.

The patient is turned again into the prone position, and by tilting the table, the opaque column is maneuvered beneath the needle. The oil is aspirated and a roentgenoscopic check made to be certain that as much of it was removed as was practicable. Using the over-the-table tube, a 10×12 inch film, centering on the lumbar puncture needle, is exposed. This film is used to orient the small films properly. The needle is withdrawn, and the examination is at an end.

Since most of the cases of protruded intervertebral disc have occurred at the fourth and fifth interspaces, only the last three interspaces are examined. This obviates extensive roentgenoscopic radiation of

the patient, and the exposure of an excessive number of films. Where the clinical examination indicates, the upper segments of the spine are examined.

If a nerve sleeve fails to fill, the column is moved back and forth by tilting the table to "inject" the oil into the sleeve. The movement of the oil produced by coughing is also used as an aid.

The roentgenograms are made with the roentgenoscopic tube using a "spot" film device. The anteroposterior and moderate oblique views are the only ones made. The lateral projection, made with the roentgen-ray beam either horizontal or vertical has not been as helpful as the oblique views. In addition, satisfactory roentgenograms are obtained much more readily in the oblique position.

#### CASE REPORTS

The 5 cases of small midline protruded intervertebral discs were detected by myelography using pantopaque. All were proved at operation. In each instance the patient obtained relief of symptoms following removal of the protruded disc. The cases formed part of a group of over 150 cases examined by myelography, 86 of which were operated upon.

CASE 1. F. A. C., aged thirty-one. This soldier was admitted to a station hospital complaining of progressively severe backache following Judo instruction. His back was strapped, but he could not get out of bed the next day. On examination, the patient listed to the left; straight-leg raising was limited to 30 degrees on the right and to 45 degrees on the left. There was localized tenderness over the left erector spinae. Clinical examination showed the lumbosacral joint to be normal.

Examination at this hospital showed a slight scoliosis of the spine, convexity to the left. There was about 10 degrees' limitation of motion, and a positive Lasègue sign, on the right side. The right ankle jerk was diminished.

The myelographic examination showed no abnormalities until the inferior margin of the opaque column was brought to the upper edge of the lumbosacral disc (Fig. 1*b*). At this point the edge of the pantopaque showed a defect, concave downwards, on the right side. As the

opaque material was slowly advanced across the interspace, it was seen to envelop progressively a rounded defect on this side (Fig. 1*c*). Yet when the interspace was completely bridged the column was apparently normal (Fig. 1*a*). On close inspection a small trans-

sized defect was partially outlined on the left side (Fig. 2*b*). In partial outline, the defect appeared larger and more prominent than when the oil column completely bridged the intervertebral space.

At operation two weeks later, a small disc

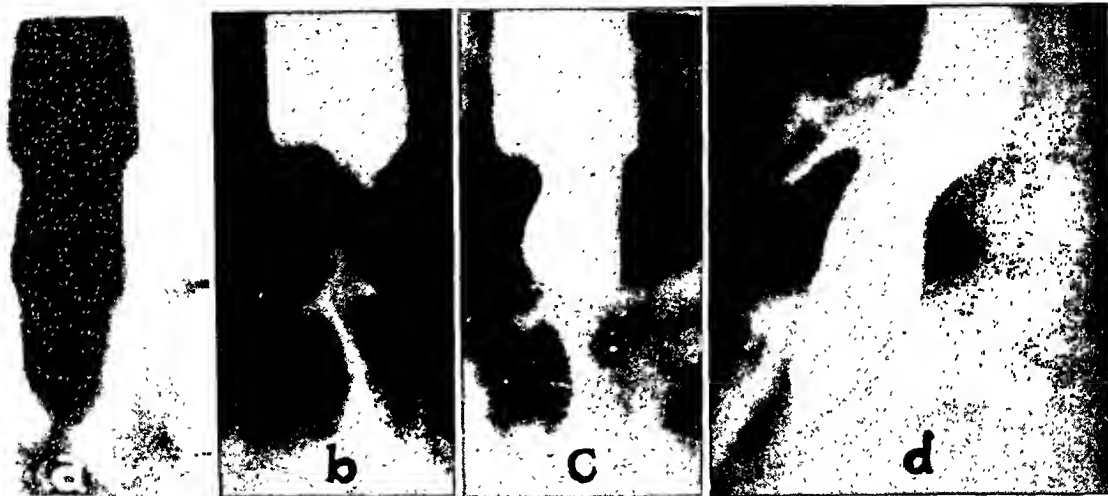


FIG. 1. Case I. *a*, the pantopaque column, lying fully across the lumbosacral disc, shows no defect or alteration of the nerve sleeves. *b*, when the oil is allowed to enter the level of the interspace gradually, a defect is produced, concave downward, in the right side of the advancing edge. *c*, with the oil advanced still farther, a defect in the right side is more clearly outlined. Referring to (*a*), an area of slight translucency may be detected at this site. *d*, in the oblique view, there is a characteristic defect in the anterior aspect of the pantopaque.

lucent area can be made out at this site and there is a slight asymmetry in the levels of the nerve exits. The oblique myelogram (Fig. 1*d*) showed a defect on the anterior aspect which also suggested the diagnosis of a small protruded intervertebral disc.

At operation a small central protruded disc was found and removed.

CASE II. J. D. J., aged twenty-eight. This soldier had a moderate back injury in 1932, without residual difficulty. He began to experience an ache in his lower back four weeks after admission. It was gradual in onset and of low intensity. It later became constant, and soon radiated to the left thigh and leg. The backache was aggravated by coughing and sitting.

On physical examination, leg stretching was painful on the left. The left knee jerk was decreased, and the ankle jerk absent.

Myelographic examination showed a slight indentation in the left side of the pantopaque column at the level of the lumbosacral disc (Fig. 2*a*). On allowing the edge of the opaque fluid to enter this area gradually, a moderate-

protrusion, almost in the midline, was seen to push a flattened nerve root posteriorly and laterally. The disc substance was removed.

CASE III. W. W. T. This soldier began to have pain in the small of the back in April, 1943, following a ride in a vehicle. The pain had become gradually worse, but still remained localized to the same area. The backache was aggravated by coughing, sneezing or bending.

The back was tender to pressure over the third and fourth lumbar vertebrae. Flexion of the back was limited. He experienced pain when he returned to the upright position after bending. The reflexes were active and equal. The hyperextension test was normal, as was the Lasègue sign. There were no sensory disturbances. All laboratory studies on the blood and urine were normal.

Myelographic examination showed a pronounced defect in the right side of the pantopaque column when the edge of the oil was allowed gradually to enter the level of the fourth intervertebral space (Fig. 3, *b* and *c*); not only was this seen when the column was brought

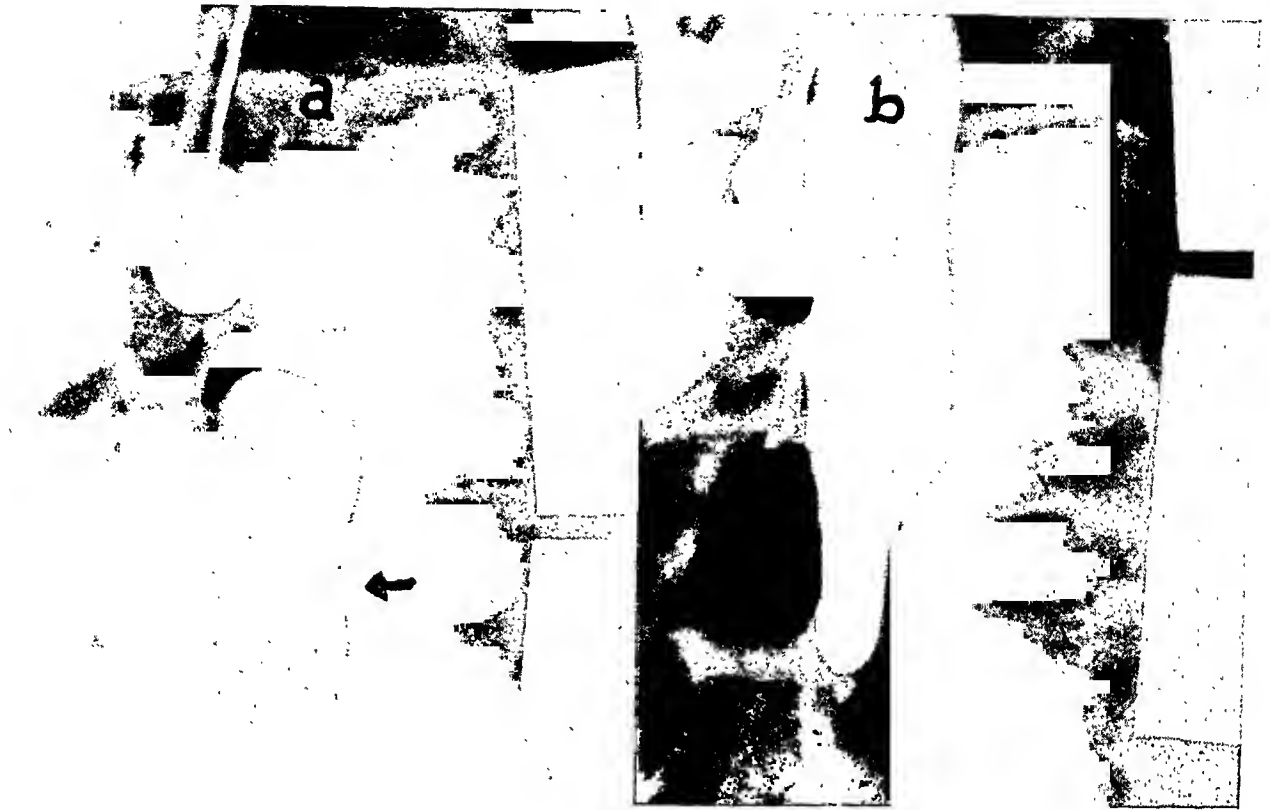


FIG. 2. Case II. *a*, there is slight flattening along the left side (arrow) which was persistent on several of the myelograms. *b*, when the edge of the oil was allowed to enter this region, there was evidence of a definite defect. The evidence noted in (*a*), without that observed in (*b*) was insufficient for a diagnosis of a disc protrusion.

downwards, but the lower margin of the defect was outlined when the oil was allowed to ascend from the cul-de-sac (Fig. 3*d*). When the oil bridged the entire interspace no defect could be

seen (Fig. 3*a*), but there was a slight elevation of the left nerve root as compared with the right. The oblique projections also showed the defect in the opaque column (Fig. 3*e*).



FIG. 3. Case III. The myelograms are arranged so that the affected disc (fourth) lies at the same level in all. *a*, the full column of oil shows no defect or alteration of the nerve sleeves. *b*, no defect is seen as the oil enters the upper level of the interspace. *c*, as the oil slides just a little farther, it outlines the left side of a defect. *d*, the oil was allowed to descend to the cul-de-sac and then brought upwards; the lower edge of the defect is outlined. *e*, the oblique view demonstrates a characteristic defect in the anterior aspect of the oil column.

At operation, a centrally situated disc protrusion was discovered and the disc substance removed.

CASE IV. F. M. N., aged thirty. In January, 1943, this patient noted low backache while doing desk work. About a month later he had a severe attack of backache, without radiating pain, which lasted three or four days. About two months after the onset of the original pain, he had another severe attack, this time with severe pain in his left leg. He improved slowly with bed rest. A month later he was hospitalized

On myelographic examination, a small concavity was noted in the lower edge of the pantopaque column at the lumbosacral interspace (Fig. 4*b*). When the entire interspace was bridged by the opaque oil, no defect could be seen (Fig. 4*a*). These findings were not discovered during the roentgenoscopic examination. A small amount of pantopaque remained in the dural sac, so the patient was re-examined. Even though the amount of oil was small, it appeared to surround the upper pole of a small disc protrusion (Fig. 4, *c* and *d*). Another



FIG. 4. Case IV. *a*, the appearance of the pantopaque column is normal when the interspace is fully covered. *b*, a defect, concave downwards, at the inferior margin appeared to outline the upper edge of a disc protrusion. This had not been noted during the roentgenoscopic examination. *c* and *d*, the patient was recalled, and although the amount of oil remaining was very small, it could be made to outline the upper margin of a small protruded disc. *e* and *f*, in order to verify these findings, the myelographic examination was repeated at a later date. A defect is again demonstrated. Oblique views confirmed the diagnosis of a disc protrusion.

for persistent back pain, with radiation to his left leg, which was aggravated by coughing and sneezing.

There was deep tenderness at the level of the fourth lumbar vertebra on the left side. Hyperextension of the leg was limited by pain. Straight leg raising was possible to 85 degrees on the right and 50 degrees on the left, with a positive Lasègue sign on this side. There was a zone of hyperesthesia to pin prick on the lateral aspect of the left lower leg and the external malleolus. The left ankle jerk was slightly decreased and easily exhausted

examination with the full amount (3 cc.) of the oil definitely outlined the small protrusion which had been suggested at the time of the first myelographic examination (Fig. 4, *e* and *f*). There was evidence also of a small protrusion of the fourth lumbar disc.

At operation, a small but definite central protrusion was seen at the lumbosacral disc, accompanied by localized scarring of the posterior longitudinal ligament.

CASE V. J. A. K., aged twenty-four. While on maneuvers in October, 1941, a vehicle in which this soldier was a passenger overturned. He

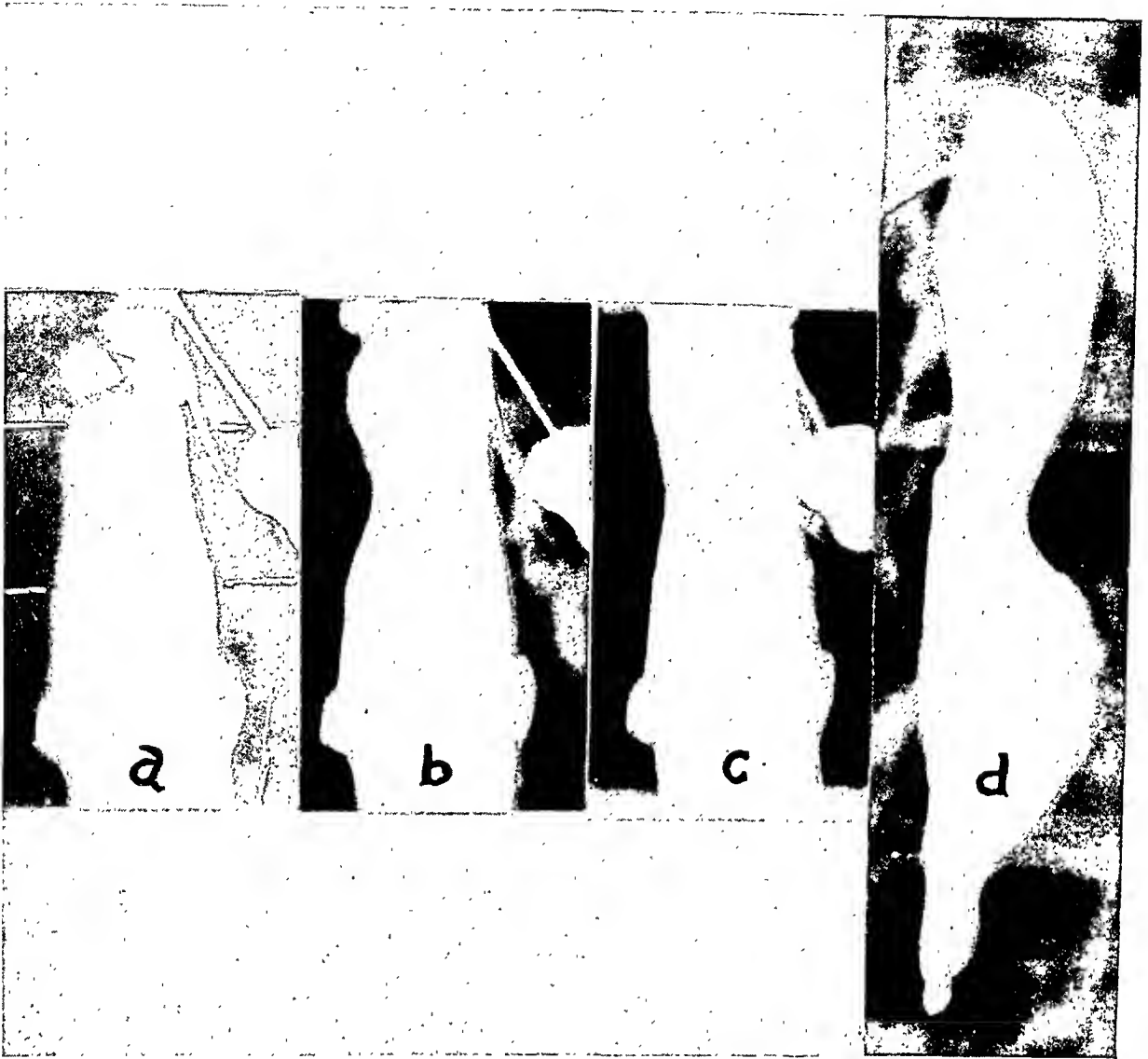


FIG. 5. Case v. The margins of the interspace in (a) are retouched. The interspace is at the same level in all of the illustrations. *a*, *b* and *c* show the persistent translucency at the intervertebral interspace with a suggestion of a constriction in this region. *d*, the oblique view indicates the diagnosis of a protruded disc.

suffered an acute low back strain which incapacitated him for three days. Since then he has had constant low back pain, which was worse on arising in the morning. He had suffered acute attacks of left sciatic pain which lasted from a few minutes to several days. Coughing often aggravated the pain.

There was deep tenderness at the left side of the third lumbar vertebra. Flexion was one-half of normal; all other movements were normal. Straight leg raising was impaired, and a positive Lasègue sign was present on the left side. Naffziger's sign was also positive. The knee and ankle joints were normal. There were no sensory changes.

The myelographic examination showed no

defect in the margins of the pantopaque column, but did show a persistent localized translucency in the midline at the level of the third lumbar interspace (Fig. 5, *a*, *b* and *c*). The oblique views showed an indentation at the anterior aspect of the opaque column (Fig. 5*d*).

At operation, on exposure of the left side of the third lumbar interspace the nerve sheath was seen to be pushed posteriorly and slightly laterally; it was adherent to a large protrusion of the third lumbar intervertebral disc; the disc was removed.

#### DISCUSSION

In this group of cases—all central disc protrusions—4 were detected by careful



observation of the slowly advancing edge of the pantopaque column to outline a small herniation or rupture of the disc substance. In 4 of the 5 cases the outline of the oil column was practically normal when it completely bridged the level of the protrusion aside from asymmetry of the nerve exits. In the other case (Case II) there was a slight deformity which in itself was insufficient to warrant a positive diagnosis. In 1 of the cases (Case V) only a translucent area in the frontal projection suggested the presence of the small disc protrusion.

The defect in each case was small, yet in each case it was productive of pain and, in each case, relief from the pain was obtained after removal of the protruding disc.

The discovery of these lesions was undoubtedly facilitated by the use of pantopaque. This new opaque myelographic medium was introduced within the past two years. Clinical use at this hospital in over 150 myelographic examinations in the period of slightly over a year has supplied convincing proof of its many advantageous properties.

Contrast myelography, first described by Dandy<sup>2</sup> in 1919 has since come into considerable use, particularly in the detection and localization of protruded intervertebral discs. Air was the first contrast substance suggested and used. It is still staunchly advocated by a few, although the consensus that its accuracy and definition are well below that of lipiodol can hardly be questioned. This latter substance, introduced by Forestier and Sicard,<sup>4</sup> came into extensive use. Thorotrast, despite its many desirable features, is not used because of its radioactivity and the inconvenience encountered in its complete removal.

Of late there has been a great decrease in the use of lipiodol in spite of the excellent use which had been made of it in the past. This may be due in part to occasional clinical reactions, the frequent difficulty encountered in its removal and the aggravation of symptoms which frequently occur when it is incompletely removed.

Pantopaque is a very freely flowing, oily substance which has given the distinct impression that it has less tendency to break up into globules than does lipiodol. It maintains itself in a homogeneous column, which fills the nerve sleeves very readily.

Pantopaque casts an excellent shadow on the roentgenogram but it is not so opaque that it obscures fine gradations of density. It is not radioactive. It is a stable solution which is not miscible with spinal fluid. Chemically it is a mixture of ethyl esters of isomeric iodophenylundecylic acids. The material has proved to be nontoxic both on experimental and clinical use. In most of the patients all but a few droplets has been removed. Occasionally, because the needle was somewhat off center, it was found impossible to remove any or all of it.

In all but one of the patients in whom the opaque material has been allowed to remain, no ill effects of any kind were suffered.<sup>9</sup> There were no symptoms other than those for which the patients were admitted to the hospital. This includes 2 of the patients examined for cervical protruded discs in whom a small amount of pantopaque entered the cranial cavity. One case in which the material was inadvertently injected epidurally also showed no symptoms or reactions to the drug. The only case in which symptoms occurred was a recent patient whose upper dorsal spine was examined; about 1 cc. of the material entered the cranial cavity in the region of the pontine cistern. This patient became nauseated and vomited. It is conceivable that the reaction was not specific for pantopaque but could have been produced by any fluid which had been displaced in the same way.

Pantopaque is said to be absorbed slowly (about 1 cc. a year).<sup>8</sup> We have had no follow-up studies longer than six months after the original examination and therefore cannot attest to its absorbability. Since the material is so innocuous and unproductive of reactions, the question of absorbability seems unimportant, either clinically or medicolegally. Most of the pantopaque in the few patients examined up to six months



after myelography had remained freely movable; the rest usually extended along the lumbar or pelvic nerves. It may be deduced from this that a reactive arachnoiditis has not resulted.

The great variety of conditions with low back pain, with or without sciatic radiation as a manifestation, makes a differential diagnosis difficult from a clinical point of view. While it is true that a well developed case of protruded intervertebral disc may be detected in the majority of the cases (about 60 per cent)<sup>7</sup> by clinical examination alone, it seems unreasonable to resort to exploratory procedures in the other cases when a harmless and easily performed method of investigation is available.

The accuracy of the procedure using pantopaque can logically be expected to be greater than that of the clinical investigation alone. With very few exceptions, in experienced hands, this method will permit discovery of a disc lesion. It lends itself admirably to the detection of the early small protruded disc, which has been demonstrated to our satisfaction as the causative lesion in a small group of cases of troublesome low backache.

The myelographic examination will also demonstrate the level of the protrusion, whether it is single or multiple, and, frequently, whether the defect is due to a disc lesion or a tumor.

#### SUMMARY AND CONCLUSIONS

The characteristic lateral defect in the opaque oil column which is indicative of a protruded intervertebral disc is absent in a small but significant group of cases when careful roentgenoscopic observation of the moving opaque column is employed. Frequently the patients in this group complain of low back pain which does not radiate early in the course of the disease. Often there is serious doubt from the clinical examination concerning the diagnosis of a

protruded disc unless myelographic evidence of a small central disc protrusion is elicited.

In the performance of myelography in cases which are suspected of suffering from disc protrusion it is important to allow the edge of the oil column to advance slowly and gradually so that the margins of a small protrusion will be outlined before the bulk of the oil obscures it. Five cases of small central disc protrusions were discovered in this way.

The myelographic examination is greatly facilitated by the use of pantopaque, a new medium developed especially for this purpose. It is of low viscosity, unproductive of reactions, tends to remain homogeneous, and is not excessively opaque.

Appreciation is expressed to Dr. M. L. Sussman for his helpful suggestions in the preparation of this paper.

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# IODIZED OIL MYELOGRAPHY OF THE CERVICAL SPINE\*

## OBSERVATIONS ON THE NORMAL AND ON FIVE PATIENTS WITH RUPTURED INTERVERTEBRAL DISCS OF THE LOWER CERVICAL SPINE

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ALTHOUGH widespread attention has been directed to the diagnosis of herniations of the nucleus pulposus of the lower lumbar spine, similar lesions in the lower cervical region have also been described. Love and Walsh<sup>5</sup> and Dandy<sup>2</sup> reported that ruptured discs occur in the lower lumbar region in approximately 96 per cent of cases. Mixter and Ayer,<sup>6</sup> however, encountered 8 patients out of 34 in whom the protrusion of the nucleus pulposus occurred in the lower cervical region. Hawk<sup>4</sup> collected 16 such cases and reported 1 additional patient. Semmes and Murphey<sup>8</sup> ventured the opinion that the incidence of this lesion is not infrequent in their report on the syndrome of unilateral rupture of the sixth cervical intervertebral disc.

The roentgenologic approach to the diagnosis of herniation of the nucleus pulposus of the lower cervical spine, particularly iodized oil myelography, merits further attention. Stookey<sup>9</sup> ascribes some significance to narrowing of the intervertebral spaces in this diagnosis when accompanied by definite neurologic signs suggestive of one of the syndromes of spinal cord compression or root pain. However, he deemed it inadvisable to use iodized oil because it might enter the basal cisterns and possibly the cranial cavity over the cerebral cortex. Semmes and Murphey concluded that in their patients the diagnosis could be made more accurately by clinical means than by the use of contrast media. Neither reported myelographic observations, although the latter mentioned that one of their patients had had iodized oil studies elsewhere with negative results.

We have had the opportunity of studying 5 patients with rupture of the nucleus pulposus of the lower cervical spine. There were 76 patients in our entire series of ruptured discs, the remaining 71 occurring in the lower lumbar region. Oil myelography as well as routine roentgenographic studies of the affected region were made on each of 38 patients, and operative confirmation was obtained in all.

Myelography was performed after the instillation of 1.5 to 2 cc. of pantopaque or lipiodol into the lumbar subarachnoid space. The patient was then placed face down on a motor driven tilt table equipped with a device for spot film roentgenography. With the patient held securely in place, the table was tilted and the movement of the oil column followed roentgenoscopically. It was necessary to invert the patient to an angle of from 70 to 85 degrees for the oil to enter the upper thoracic and lower cervical regions. The movement of the table was under the control of the observer, so that if the oil passed too rapidly into the lower cervical canal the table could be returned promptly to the horizontal position. In this way it was possible to prevent the entrance of the opaque medium into the cranial cavity.

### OBSERVATIONS ON NORMALS

It was considered essential to familiarize ourselves with normal myelographic findings in the cervical spinal canal. This was done on 8 patients in whom myelography was indicated for other reasons and who had no symptoms or signs referable to the cervical region.

\* From the Neurosurgical Service of Dr. L. M. Davidoff and the Radiologic Service of Dr. M. G. Wasch, The Jewish Hospital of Brooklyn.

While the opaque medium flowed through the lumbar spine it passed as a solid column. Approaching the thoracic spine, particularly the cephalad third, there was a definite tendency for the oil to break up into various sized droplets. When this occurred it was necessary to repeat the examination after returning the patient to the erect position to permit the oil to collect in the lumbar sac. A satisfactory examination could not be made unless the oil was kept in as complete a column as possible.

Assuming that the opaque medium passed satisfactorily as a solid column into the cervical canal, the observer had to be alert to detect the changes which occurred at the level of the lower three cervical vertebrae. There is a normal hesitation at the region of the distal portion of the cervical canal which is very transitory. Following this pause the column usually passed to either side of the canal, outlining the axillary pouches as tiny triangular shadows with their apices directed laterally following the configuration of the cervical nerves as they pass through the intervertebral foramina (see Fig. 1, 2 and 3). It was difficult to fill the entire cervical canal, but it could be accomplished by tilting the patient up and down to collect the oil in the lower cervical canal.

These observations assume added importance because the myelographic changes associated with herniation of the nucleus pulposus of the lower cervical spine reported here are principally changes in the rate of flow and appearance of the oil column.

#### OBSERVATIONS ON PATIENTS WITH HERNIATION OF THE NUCLEUS PULPOSUS OF THE LOWER CERVICAL SPINE

Four of the patients with herniations of the nucleus pulposus of the lower cervical spine presented a roentgenologic picture of partial obstruction to the passage of iodized oil in the affected region which was fairly uniform, could be repeated on the same patient with identical results and has not to our knowledge been described up to the

present time. The fifth patient had a complete cerebrospinal fluid block.

The following observations were common to 4 patients. As the oil column approached the lower cervical region, which occurred when the patient was almost inverted and usually after several attempts, it halted briefly but definitely longer than normal at the level of the lesion, changing its appearance to a large globule with a flat or convex base directed cephalad. After a few seconds a thin trickle of oil appeared either to one or both sides of the lesion. As the obstruction was passed the oil fell in various sized droplets with increased speed toward the cisterna magna.

Although the delay in the passage of the iodized oil at the site of the lesion was brief a few serial spot roentgenograms could be made of the process. Adequate information was usually obtained without oil entering the cranial cavity. In 1 patient some lipiodol entered the cisterna magna but emerged after the patient had been placed in a semi-erect position for a few hours.

On the spot roentgenograms the oil was first seen gathered in a large globule with a flat or convex base simulating a cap-like configuration. Successive roentgenograms showed a thin trickle of oil passing to one or both sides of the spinal canal for 2 to 5 cm. Beneath this and between the lateral ribbons of oil, droplets were scattered. Viewing the roentgenograms in the position in which they had been taken, i.e., head downwards, a characteristic appearance like that of an inverted "U" or "L" with broad base and thread-like arms with oil droplets beneath and between the arms was seen. In contrast with the normal appearance, the oil did not enter the axillary pouches.

Our observations indicated that ruptured intervertebral discs protruding into the lower cervical canal might result either in no obstruction or partial or complete block. In those patients with little or no cerebrospinal fluid block the myelograms resembled those described by Walker, Jessico and Marcovich<sup>10</sup> for intramedullary cord tumors. However, several significant

differences were noted. Intramedullary cord tumors act on iodized oil within the spinal canal by compressing the oil between the tumor mass and the periphery. This results in a cap-like defect proximal to which lateral streaks may extend for several segments on one or both sides of the canal, depending on the length and diameter of

myelographic characteristics of herniation of the intervertebral disc in the lower cervical region are transitory, while an intramedullary spinal cord tumor produces a more or less fixed appearance.

Complete intraspinal block occurred in 1 patient out of the 5 reported here. When present it cannot be distinguished from that

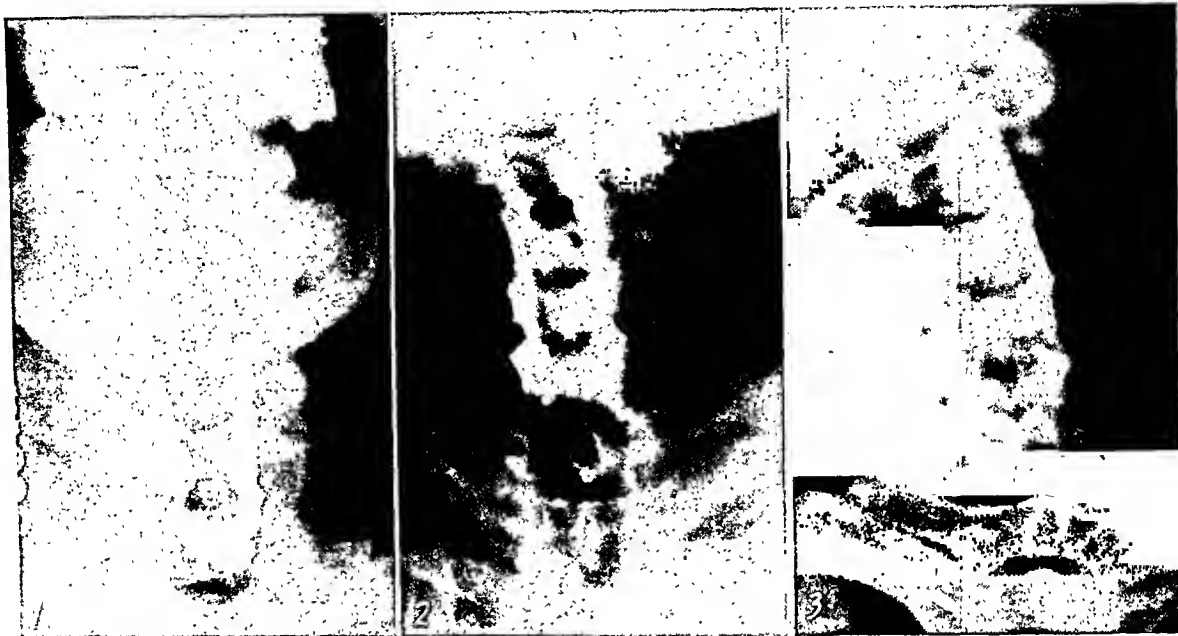


FIG. 1. Spot roentgenogram made with the patient inverted during iodized oil myelography of the cervical spine in a normal individual. Most of the opaque oil has passed to either side of the spinal canal outlining the axillary pouches. Oil droplets are present between the lateral ribbons and are gathered at the interspace between the sixth and seventh cervical vertebrae.

FIG. 2. Spot roentgenogram made during iodized oil myelography of a normal cervical region. The axillary pouches are well filled, and the iodized oil at the time this roentgenogram was made had assumed a rapidly transient "U" appearance.

FIG. 3. Spot roentgenogram showing the entire cervical canal filled with iodized oil. The axillary pouches are well portrayed.

the tumor. Small triangular protrusions may be seen between the pedicles due to lipiodol in the axillary pouches, as can be noted on the illustrations in the paper by these authors.<sup>10</sup> In the presence of a herniated disc of the lower cervical spine the cap-like defect is transitory and unless watched for carefully may be overlooked. The lateral streaks are shorter, and the opaque oil does not gather in the axillary pouches. The presence of oil droplets between the lateral streaks is significant because it indicates the absence of a mass in that region. The

due to extramedullary tumors. The latter, in contrast with herniated discs, are often associated with changes in the adjacent osseous and soft tissue structures which may be of diagnostic importance.<sup>3</sup>

Other uncommon conditions such as a cyst of the spinal cord,<sup>1</sup> or syringomyelia,<sup>7</sup> or a perineural fibroblastoma\* may simulate an intramedullary tumor and therefore might be confused with a herniated disc in the lower cervical region.

\* Unreported verified cases operated upon at the Jewish Hospital.

## REPORT OF CASES

CASE I. J. L., male, aged forty-nine, first noted difficulty in using his left leg while walking and weakness of his left hand three months before admission. He had been aware of a tingling "pins and needles" sensation in his left hand prior to this. One month before admission tingling appeared in his right hand.

Physical examination revealed partial ptosis

The cerebrospinal fluid was crystal clear, and normal hydrodynamic responses were obtained. The protein content was 47 mg. per 100 cc.

Anteroposterior and lateral roentgenograms of the cervical spine revealed slight arthritic changes in the lower cervical vertebrae with normal interspaces. Myelography after the instillation of 2 cc. of pantopaque in the lumbar sac showed free passage of the opaque medium

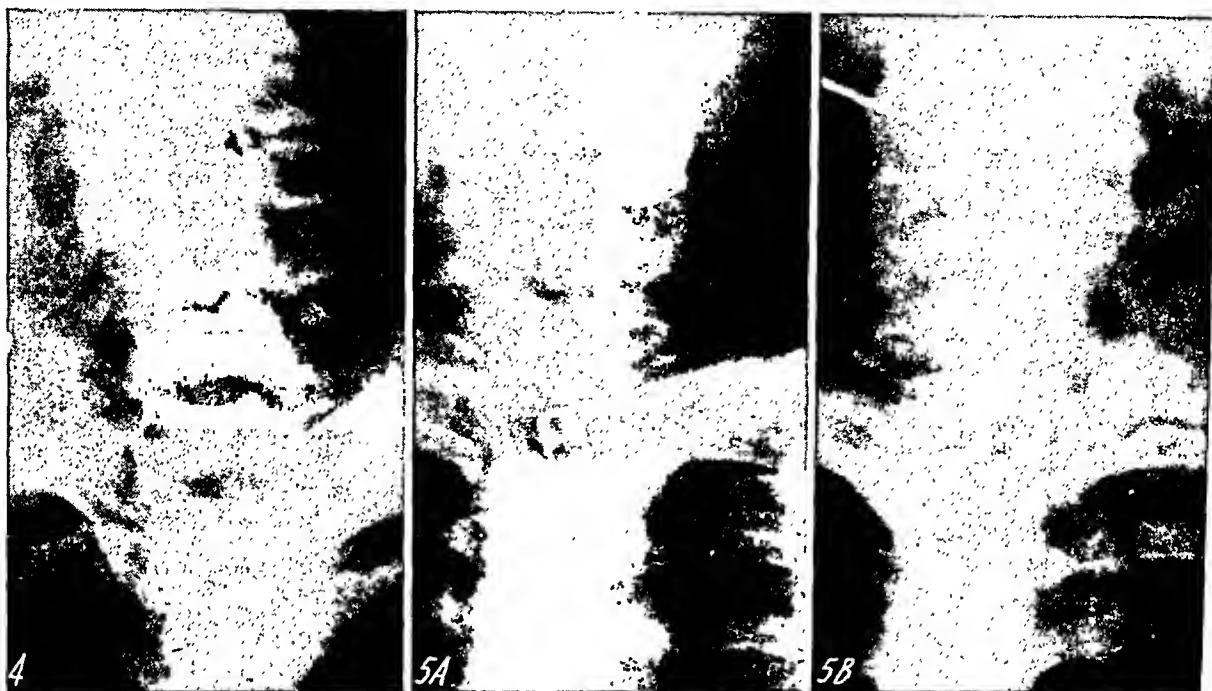


FIG. 4. Case I. Spot roentgenogram with the patient inverted. The lipiodol assumes a "U" appearance which is more lasting than normal, with droplets of oil beneath and between the lateral streaks.

FIG. 5. Case II. *A*, spot roentgenogram taken just as the oil reached the site of the lesion. The pantopaque column presents a cap-like deformity which might be confused either with an intramedullary or an extramedullary tumor. *B*, spot roentgenogram a few seconds later. The lateral streaks of iodized oil are broken, and oil droplets are seen between them.

of his left upper eyelid. There was weakness of his left upper extremity with ataxia and adiadokinesis. A left Hoffmann sign was elicited. The abdominal reflexes were diminished on the left side. The knee jerks were hyperactive bilaterally. There was bilateral ankle clonus and patellar clonus on the left side. A positive Babinski sign was present on the right. Position sense of the right big toe was impaired, and vibratory sense of both lower extremities was diminished. Pain sensation was decreased on the right side from the level of the sixth thoracic segment down, but the saddle area was spared. There was spasticity of both lower limbs, more marked on the left side.

through the lumbar and thoracic canal. At the level of the interspace between the fifth and sixth cervical vertebrae there was a temporary obstruction, and the column changed its appearance momentarily to a large globule with a flat base. Soon thereafter the opaque oil passed to either side of the cervical canal. Roentgenograms made during this time revealed a "U"-shaped configuration with droplets of oil beneath the base of the "U."

At operation a definite herniated disc was found between the fifth and sixth cervical vertebrae compressing the spinal cord anteriorly. The herniation protruded on both sides. The pia-arachnoid vessels were markedly injected

and there were numerous adhesions between the arachnoid and dura. The adhesions were broken and the laminectomy was affected to act as a decompression. Only slight subjective improvement followed the operation.

CASE II. B. G., female, aged forty-five, suddenly noted weakness and numbness in both legs about six weeks before admission. Her legs felt "heavy" and she had to drag them in an effort to walk. There was no pain at this time, and her symptoms were attributed to her diabetic condition. Two weeks before admission she had severe low back pain on arising in the morning. The pain was sharp and did not radiate until two days later when it extended to both flanks, abdomen and the upper gluteal regions. There was no history of lifting or straining.

Physical examination revealed the deep reflexes to be equal and active. Normal plantar responses were obtained bilaterally. The abdominal reflexes were absent. No motor weakness or atrophy was found. There were moderate subjective changes consisting of hyperalgesia below the level of the sixth thoracic segment anteriorly. Pain and temperature sensations were unimpaired.

The cerebrospinal fluid was crystal clear. There was a partial block, the initial pressure being 140 mm. and the final pressure after the removal of 10 cc. of fluid being zero. The cerebrospinal fluid proteins were 74 mg. per 100 cc.

Anteroposterior and lateral roentgenograms of the cervical spine showed normal bodies and interspaces. Oil myelography after the injection of 2 cc. of pantopaque into the caudal sac revealed a partial obstruction at the level of the interspace between the sixth and seventh cervical vertebrae. The oil then trickled to either side of the spinal canal and several droplets fell cephalad. Spot roentgenograms confirmed these observations which were reported as suggestive of a herniated disc at this site.

At operation a laminectomy of the fifth, sixth and seventh cervical vertebrae and the first thoracic vertebra was performed. On the left side of the cord between the sixth and seventh cervical vertebrae there was a posterior bulge of the anterior surface of the canal, the appearance of which was quite suggestive of a posterior herniation of the intervertebral disc. Removal was deemed inadvisable. There was no definite improvement after operation.

CASE III. E. G., male, aged sixty-one, first noted spasmodic clonic contractions of his left leg one year before admission. These occurred several times a week, principally at night. There was no pain associated with them, nor was there any history of trauma or strain. About six months later pain appeared in his right shoulder, followed by tremors of the right upper extremity, weakness and poor coordination of the movements of his right hand. The pain in his right shoulder was increased by coughing. He also complained of choking sensations in the sternal region, but cardiologic examination including electrocardiographic and roentgenologic studies showed no evidence of heart disease.

Physical examination revealed his left pupil to be smaller than the right, with enophthalmos of the left eye and slight ptosis of the left lid. The cranial nerves were intact. There was diminution of pain sensation on the right side from the level of the third cervical vertebra downward, with the saddle area spared. The deep reflexes were equal and active. Slight ataxia was noted in the heel to knee test bilaterally. A positive Babinski sign was elicited on the left side. Vibratory sense was unimpaired.

The cerebrospinal fluid was crystal clear, and normal hydrodynamic responses were elicited. The cerebrospinal fluid protein content was 70 mg. per 100 cc.

Anteroposterior and right lateral roentgenograms of the cervical spine revealed marked hypertrophic osteoarthritis, particularly of the lower cervical segments, with narrowing of the lower intervertebral spaces.

Myelography after the instillation of 2 cc. of lipiodol revealed a temporary obstruction at the level of the sixth cervical vertebra. After a brief delay a thin stream of oil passed to the left side of the canal resulting in an "L"-shaped shadow which was considered suggestive of a herniation of the nucleus pulposus.

At operation a ruptured disc was found on the left side of the sixth cervical intervertebral space. The dura over this region was opened and dense adhesions of the pia-arachnoid to the entire surface of the dura were found. A decompression of the lower cervical canal was affected by means of laminectomy of the fourth, fifth and sixth cervical vertebrae. The mass protruding into the spinal canal was not attacked. After operation the patient suffered a cerebral thrombosis and died. Autopsy permission was denied.



CASE IV. A. B., male, aged forty-seven, felt a sharp pain in his right shoulder ten months before admission. This occurred while he was lifting a hundred pound weight onto a truck. The next day the pain radiated to the back of his neck, and his head was tilted towards the right side. This lasted two days, and attempts to bring his head back to the midline were quite painful. A few days later pain appeared in his

weakness of the grip of his left hand, and a definite intention tremor of his right hand. A slight left foot drop was present, and there was poor coordination in the performance of the heel to knee test bilaterally. The abdominal reflexes were diminished. Positive Hoffmann and Babinski signs were elicited on both sides, the right more active than the left. There was bilateral exhaustible ankle clonus.

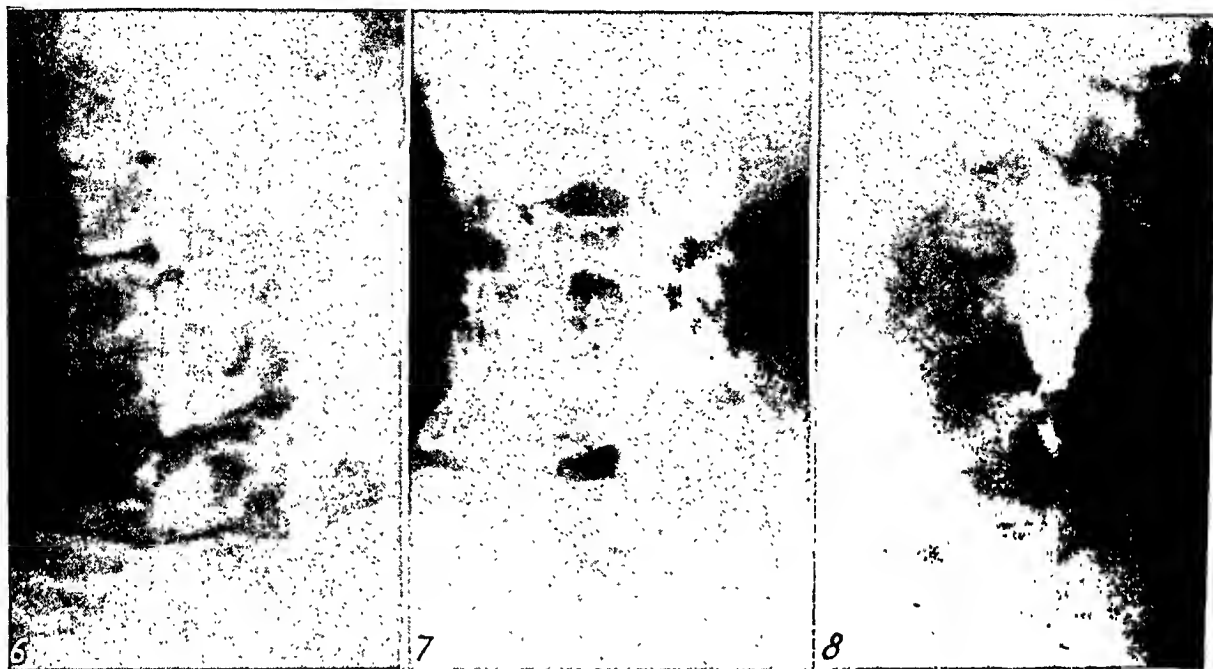


FIG. 6. Case III. Spot roentgenogram showing an "L" configuration of the iodized oil column.

FIG. 7. Case IV. Spot roentgenogram showing "U" configuration of the lipiodol column. The oil does not gather in the axillary pouches of the lower cervical nerve roots.

FIG. 8. Case v. Spot roentgenogram revealing a complete cerebrospinal fluid block.

left shoulder. He was bedridden for the next six weeks, and the pain gradually subsided. He then returned to work, and was symptom free for two weeks. The pain recurred after a prolonged period of driving. A spinal tap done soon thereafter was reported as normal. Four months before admission his gait became abnormal in that his toes hit the ground first while he was walking, and he had difficulty in maintaining his balance. About this time he began to feel numbness and coldness in his left great toe. Recently his finger tips became numb, and pins and needles sensations appeared. He also had difficulty in performing finer hand movements because of a progressive intention tremor in his right hand. The symptoms had become more marked up to his admission to the hospital.

On physical examination there was a slight

The cerebrospinal fluid was clear, and normal manometric responses were obtained. The cerebrospinal fluid protein content was increased to 72 mg. per 100 cc.

Anteroposterior and lateral roentgenograms of the cervical spine showed slight osteoarthritic changes in the lower cervical vertebrae. Iodized oil myelography revealed a temporary obstruction at the fifth cervical interspace. A few seconds after the oil column reached this site lateral streaks of opaque oil could be seen passing to either side of the spinal canal resulting in a "U" configuration. The spot roentgenograms confirmed these observations.

At operation laminectomy of the fifth, sixth and part of the seventh cervical vertebrae was performed. A herniation of the nucleus pulposus between the fifth and sixth cervical vertebrae

was seen coming from the left side pushing the cord posteriorly and towards the right side. The anterior nerve roots were displaced posteriorly and inferiorly.

After operation there was some improvement so far as his sensory disturbances were concerned, but the changes in gait persisted.

CASE V. J. B., male, aged fifty-seven, suddenly felt a peculiar prickling sensation in both palms about five months before admission to the hospital. Six weeks later numbness appeared in both hands. Weakness and cramps of both hands followed. There was no recent history of trauma or unusual strain. His right lower limb had been amputated three years ago because of gangrene following trauma.

Physical examination revealed weakness of both upper limbs, more marked on the right. There was beginning spasticity of his fingers. The deep reflexes in both upper extremities and the remainder of the left leg were increased. A bilateral Hoffmann sign was present, and the abdominal reflexes were diminished bilaterally. There was loss of sensation to pain and temperature in a zone corresponding to the fourth cervical to first thoracic segments. Touch was preserved in this area. Position sense was markedly impaired in the fingers of both hands, and occasional errors were noted in his toes. Vibratory sense was diminished below the level of both clavicles. Stereognostic sense was impaired in both hands. There were suggestive Oppenheim and Chaddock signs in his left foot.

The cerebrospinal fluid was clear. A partial block was present, the initial pressure being 120 mm., and the pressure after the removal of 10 cc. of fluid being 62 mm. The total proteins were increased to 134 mg. per 100 cc.

Anteroposterior and lateral roentgenograms of the cervical spine revealed advanced hypertrophic osteoarthritis involving the lowermost vertebrae. Lipiodol myelography after the injection of 2 cc. of lipiodol revealed complete obstruction at the interspace between the fifth and sixth cervical vertebrae. At operation a laminectomy of the fifth and sixth cervical vertebrae was performed. Extradural exploration revealed a large herniation of the intervertebral disc protruding toward the right side. The overlying nerve roots were stretched taut. The disc could not be removed. After operation the patient noted considerable improvement in the power of his left upper extremity, but the right upper limb improved only slightly.

#### COMMENT

Four patients were men between the ages of forty-seven and sixty-one, and the fifth was a woman aged forty-five. One (Case IV) had a history of strain which was of clinical significance. One (Case III) had substernal pain which was readily distinguished from angina pectoris. Three of the herniations of the nucleus pulposus occurred between the sixth and seventh cervical vertebrae and two between the fifth and sixth.

The distribution of pain was bizarre. In contradistinction to ruptured intervertebral discs of the lower lumbar spine, where low back pain is a predominant symptom, patients with similar lesions in the lower cervical spine in this series had little pain referable to that area. Only 1 patient (Case IV) had pain in the base of the neck. Another had pain in the lower lumbar region (Case II) and 3 had no back pain at all. Weakness, paresthesias and pain in both upper limbs were observed in 1 patient (Case V). Right arm symptoms were noted in 2 patients (Cases III and IV) and 1 had sensory disturbances in the left arm (Case I). Lower extremity pain, weakness and paresthesias occurred in 4 patients, and was absent in the one who had most of his symptoms referable to his upper extremities. The latter was the patient who had a complete cerebrospinal fluid block (Case V).

The tendon reflexes were normal in 4 patients, and were increased in the one with the complete cerebrospinal fluid block. A positive right Babinski sign was elicited in 2 patients, a positive left Babinski sign was present in 1, and a doubtful Babinski sign was observed in a fourth patient. One patient (Case II) had a normal flexor response. Position sense was normal in 3 patients, and impaired in the remaining 2 patients (Cases I and V). Vibratory sense was diminished in 2 patients (Cases II and V). Three showed changes in gait of a shuffling nature, and a foot drop was seen in one. Pain and temperature sensation was diminished in 4 patients, but the levels were bizarre. Touch sensation was impaired in 2,



both of whom had pain and temperature changes.

The symptomatology in all 5 patients reported here was referable to the dorsal funiculi, the pyramidal tracts and the lateral and ventral spinothalamic tracts. The levels of the neurologic disturbances as determined clinically were at considerable variance with what might have been expected from the location of the herniated discs. These patients fell into the syndrome of compression of the spinal cord described by Stookey<sup>9</sup> with bilateral or unilateral ventral pressure, with the effects of the pressure referable to both the upper and lower limbs. Root pain was also noted, but was not a predominating symptom.

The cerebrospinal fluid dynamics were normal in 3 patients, and 2 had partial blocks. Elevated protein content was found in all but one (Case 1).

Routine anteroposterior and lateral roentgenograms of the cervical spine revealed advanced hypertrophic osteoarthritis with narrowing of the lower intervertebral spaces in 3 patients. We do not ascribe any definite significance to this finding, inasmuch as it is frequent in patients of the same age who have no complaints referable either to the spine or the central nervous system.

#### SUMMARY

Routine roentgenographic and the clinical findings may be confusing in the diagnosis of herniation of the nucleus pulposus of the lower cervical spine.

The normal opaque oil myelographic findings in this region are described, and observations made on five patients who had verified herniated discs of the lower cervical spine are reported. Myelography of the cervical canal is a procedure which can pro-

vide valuable information, and which merits further study and careful evaluation. With care it is possible to perform the examination without iodized oil entering the cranial cavity. In instances in which some of the opaque medium did enter the cisterna magna no difficulty was encountered in returning it to the spinal canal after placing the patient in the upright position.

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# A ROENTGEN ANALYSIS OF THE MOTION OF THE LOWER LUMBAR VERTEBRAE IN NORMAL INDIVIDUALS AND IN PATIENTS WITH LOW BACK PAIN

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ALTHOUGH recent years have added considerably to our knowledge of low back pain, there are still many patients in whom the most painstaking clinical and roentgen examination fails to disclose a causative factor. The reason for this is probably to be found in the fact that there are many intervertebral soft tissue structures which are invisible to the roentgen ray and inaccessible to clinical examination.

In search for more accurate roentgen diagnosis some authors have recommended that the spine be studied not only in its anatomical detail but also in its motion. So far, however, no one has attempted to analyze the vertebral movements in normal individuals and in patients suffering from low back pain.

Before attempting this analysis, one should be familiar with the structures involved and with the stresses generated by motion. From an anatomical standpoint, the movement of the vertebrae is dependent on a normal muscular action and on the integrity of the intervertebral discs and of the posterior articular facets. The type of movement of the various spinal segments is determined by the direction of the planes of the posterior articulations. For instance, the plane of the posterior articulations of the cervical vertebrae is more nearly horizontal than in other segments of the spine and this accounts for the greater mobility of this segment. In the dorsal spine, the facets are almost vertical so that this segment can rotate well, but does not flex freely from side to side. In the lumbar segment, the posterior articulations allow extension, flexion, and lateral flexion while only a slight amount of rota-

tion is permitted by the articulations of the fourth and fifth lumbar vertebrae.

The posterior articulations of the spine, strange as it may seem, are not shaped so that they will fit one another in the extreme degrees of motion. In extreme flexion and extreme extension of two vertebrae of the lumbar type, the posterior articular facets will touch each other at an angle and over a limited surface. This fact creates strains upon certain regions of the articular cartilages (Fig. 1).

The intervertebral discs form a very versatile type of joint and would allow motion in all directions were it not for the guiding action of the posterior articulations. This guiding action accounts for the fact that the flexion of the spine is accompanied by a slight forward displacement of the vertebrae while the extension is accompanied by a slight backward motion.

The motion of the vertebrae creates a series of stresses in the intervertebral discs. With the spine in flexion the discs become wedge shaped and this causes a tendency of the nuclear substance to slide backward toward the open side of the wedge (Fig. 1). The reverse holds true in extension. This tendency of the nuclear substance to slide back and forth is restrained by the annulus fibrosus and by the many fibrils which bind the soft nuclear substance to the vertebral bodies above and below. The solid bond of the nuclear substance to the vertebral bodies is easily seen upon sectioning an intervertebral disc. The nuclear substance is soft and jelly like, but cannot be easily displaced.

A factor of great importance in the function of the intervertebral discs is their internal pressure. This pressure is the result

of the load and of the force of the elastic and connective fibers which compose the structure of the annulus and which con-

into a tough elastic casing. This intranuclear pressure is obviously essential to the proper function of a disc and varies

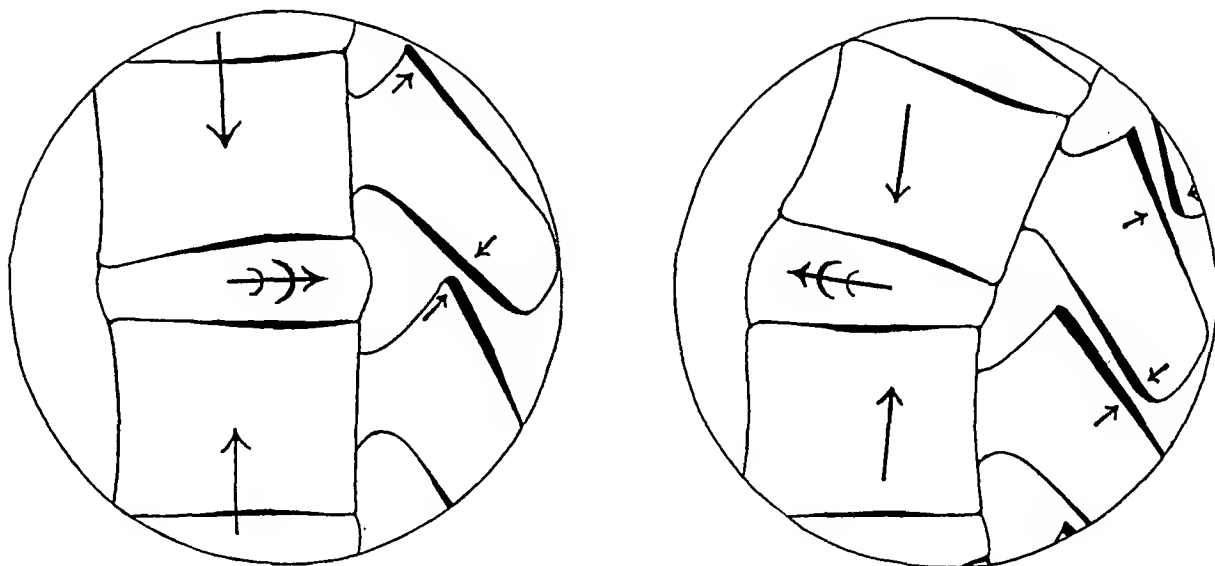


FIG. 1. Stresses upon the intervertebral discs and the posterior articular facets created by extreme flexion and extreme extension.

strict and limit the incompressible nuclear substance. An intervertebral disc may be thus likened to a tire in which an incompressible semifluid material has been forced

with the load to which the disc is subjected. For instance, the pressure within the cervical discs is bound to be much lower than that within the discs of the lumbar region. If we assume that the weight of the trunk above the fifth lumbar disc is 100 pounds and the surface of the disc is 1 square inch, then this disc may have to support a pressure of 200 or 300 pounds during the lifting of some weight, and as much as 400 or 500 pounds during a fall.

From this rather sketchy review, it appears that the normal movements of the spine are connected with several factors and that these include muscular pull, load upon the discs, intranuclear pressure, and the condition of the articular facets. These factors vary with the various regions of the vertebral column and are altered by certain pathological conditions.

A little over a year ago it occurred to me that it should be possible to give a roentgenological demonstration of the pattern of motion of the various vertebral segments. By taking three roentgenograms of the lumbosacral spine in the lateral position, one with the spine at rest, one with

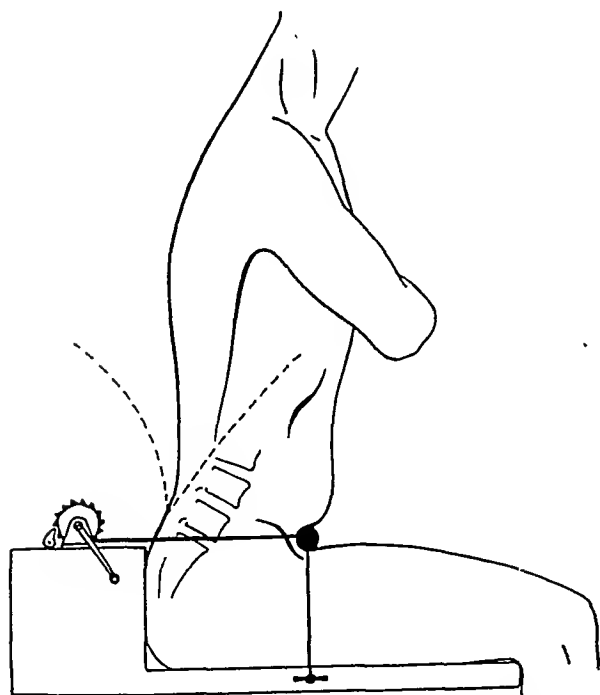


FIG. 2. Method of immobilizing the pelvis for the motion study of the lumbosacral spine.

the spine in flexion, and one with the spine in extension, I was able to see that, after superimposing the sacrum in the three roentgenograms, the shadows of the lower border of the fifth lumbar crossed each other in a definite manner. These roentgenograms were taken with the patient recumbent. Later on, a technique was developed which allowed the study of vertebral motion while the spine supported the weight of the body. This technique re-

films are exposed, one with the trunk erect, one with the trunk in maximum flexion, and one with the trunk in maximum extension, taking care that all the exposures are made with the spine in a strictly vertical sagittal plane. These three roentgenograms usually show the sacrum and the last two or three lumbar vertebrae in true profile so that the shadow of each of these structures is superimposable on the shadow of the same structure in all roentgenograms.

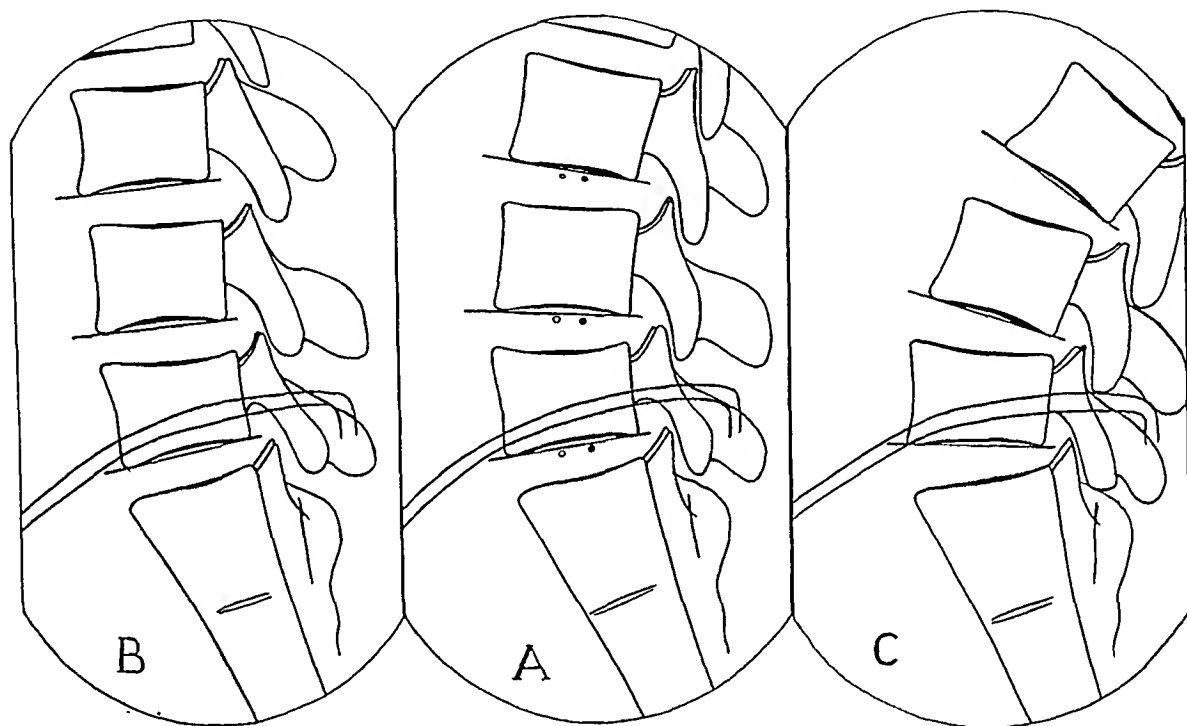


FIG. 3. Method of marking the three roentgenograms for the study of vertebral motion.

quires the use of a special seat, the essential features of which are shown in Figure 2. The patient sits in this device with the trunk erect so that the spine supports its normal load. A back rest extends as high as the upper limit of the sacrum. The pelvis is immobilized by the backward pull of two straps attached to a horizontal bar resting against the anterosuperior iliac spines. The horizontal bar is held down by two other straps secured to the bottom of the seat. The roentgen-ray beam is horizontal, and a small cone minimizes secondary radiation. The film is held by a rack on the side opposite the roentgen tube. Three

If this is not the case, referring points cannot be found and the study of vertebral motion should not be attempted. Only after having obtained a good set of roentgenograms can one proceed with their comparison and study.

The roentgenogram obtained with the trunk erect (Fig. 3, *A*) is placed on an illuminator, and, with a sharp pointed pencil, straight lines are drawn tangential to the lower contours of all the vertebrae to be studied. The roentgenogram obtained with the trunk in flexion (Fig. 3, *B*) is then placed over roentgenogram *A*, and the contours of each vertebra in the two roent-

genograms are superimposed as accurately as possible; then lines corresponding to the lines already drawn on roentgenogram *A* are drawn on roentgenogram *B*. This process is then repeated by superimposing *A* and the roentgenogram taken in extension (Fig. 3, *C*). These roentgenograms

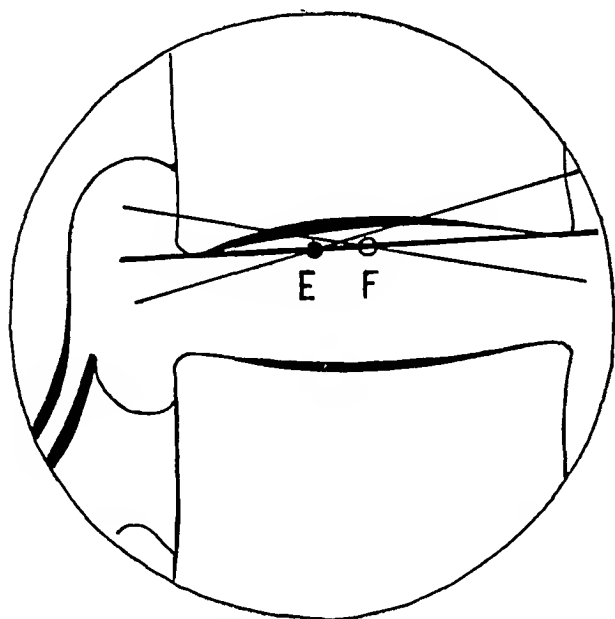


FIG. 4. Normal position of the fulcrum of motion.

are now ready for study. With the roentgenogram *A* uppermost, one superimposes the sacrum in *A* on *B*. Then one marks on roentgenogram *A*, with a small circle, the point where the lines delineating the lower edge of the fifth lumbar vertebra in the two roentgenograms cross each other. This circle represents the fulcrum of flexion of the fifth lumbar vertebra. The next step is to superimpose the sacrum in roentgenograms *A* and *C*, and, to mark on *A* with a dot the crossing of the lines drawn at the lower edge of the fifth lumbar. This dot represents the fulcrum of extension of the fifth disc.

This process is repeated for the fourth and for the third lumbar discs.

So far no routine attempt has been made to study the motion of the vertebrae above the third lumbar because such a study would require a different and more complicated device. An attempt was made to study the lateral flexion of the lumbar

spine, but was not pursued because the anteroposterior or posteroanterior views will give a good representation of only one disc at a time.

It is obvious that the terms "fulcrum of flexion" and "fulcrum of extension," although descriptive, are not very accurate. We are dealing with the flat surface of the vertebral body as it slides over the turgid nuclear substance and the marks on roentgenogram *A* actually represent the extreme points at which this surface is tangential to the ovoid shape of the nucleus. It should be understood that between the two extreme points there are many others which would be shown by roentgenograms taken in intermediate degrees of flexion and extension.

Twenty individuals between the ages of nineteen and thirty-five years, without any previous history of backache and without roentgen findings of bone lesions, were examined with the technique described above. The fulcrums of flexion and extension of the third, fourth, and fifth lumbar discs were found to lie within very narrow limits at about the center of the nuclei (Fig. 4). The average distance between fulcrums was 5 mm., with a minimum of 3 mm. and a maximum of 8 mm. The fulcrum of flexion was always anterior to the fulcrum of ex-

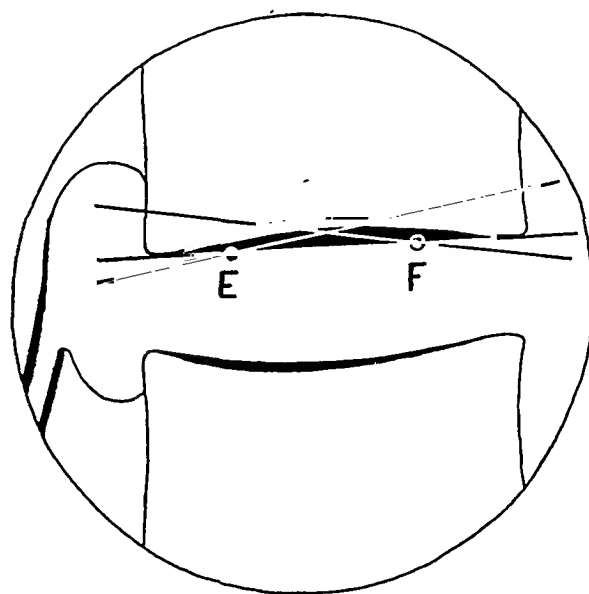


FIG. 5. Spread of the fulcrum of motion.

tension. The vertebral bodies themselves showed a complex motion: in flexion they moved slightly forward and in extension there was a slight backward component.

The pattern of motion of the lumbar spine in normal cases is evidently due to the rolling of the flat surfaces of the vertebral bodies over the nuclei, while the vertebrae are being guided by the posterior articulations. This pattern is about what one would expect from the study of the anatomical structures involved.

Thirty-five patients complaining of low back pain were studied with the same technique and the motion of their lumbar spines compared with that found in the normal individuals.

Twenty of these patients showed normal motion; 15 showed deviations from normal.

Of the 20 patients who had back pain with normal motion, 16 had no demonstrable bone lesions. Of these 16 patients, 2 had clinical symptoms of posterior herniation of the nucleus pulposus. The lesions found in the remaining 4 patients are described in Table I.

Of the 15 patients who had back pain and abnormal motion, 8 had no evidence of bone lesions. Four of these 8 patients had clinical symptoms of a posterior herniation of the nucleus. The bone lesions found in the remaining 7 patients are described in Table I. Only one disc per patient was involved in 9 of the 15 patients showing abnormal motion. Six patients, however, showed abnormal motion at more

than one level, so that in these 15 patients, abnormal motion was found a total of 21 times. The types of abnormal motion can be described as follows:

In 5 discs the fulcra were separated more

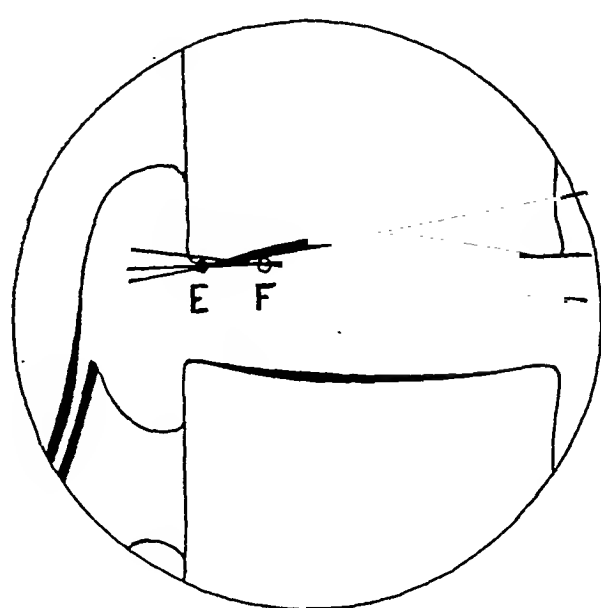


FIG. 6. Posterior displacement of the fulcra of motion.

than normally. This was due to a contemporaneous spread of both fulcra in 2 discs (Fig. 5), to a forward displacement of the fulcrum of flexion in 1 disc, and a backward displacement of the fulcrum in extension in 2 discs.

In 2 cases the fulcra were at normal distances from each other but displaced backward close to the posterior edge of the disc (Fig. 6).

TABLE I  
Number of cases with low back pain: 35

Normal motion: 20 cases (54%)		Abnormal motion: 15 cases (46%)	
Without bone lesions: 16 cases		Without bone lesions: 9 cases	
With bone lesions: 4 cases		With bone lesions: 7 cases	
Bone lesions found:		Bone lesions found:	
	Cases		Cases
Spondylolisthesis, grade 1:	1	Spondylolisthesis, grade 2:	2
Hypertrophic changes:	1	Hypertrophic changes:	1
Schmorl's nodes:	2	Osteochondritis juvenilis:	1
		Old compression fracture:	1
		Unilateral sacralization of the fifth lumbar:	2

In 4 discs there was a reversal of the normal position of the fulcra, with the fulcrum of flexion being placed posteriorly and fulcrum of extension anteriorly. Two of these also showed a marked increase in the distance between the fulcra (Fig. 7).

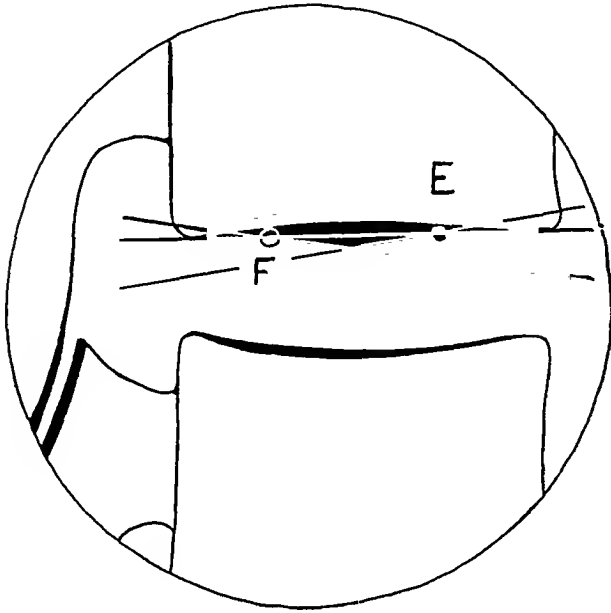


FIG. 7. Reversal in the position of the fulcra of motion.

In 2 discs the fulcrum of extension was displaced so far backward that it was found to be at the level of the posterior articulations (Fig. 8).

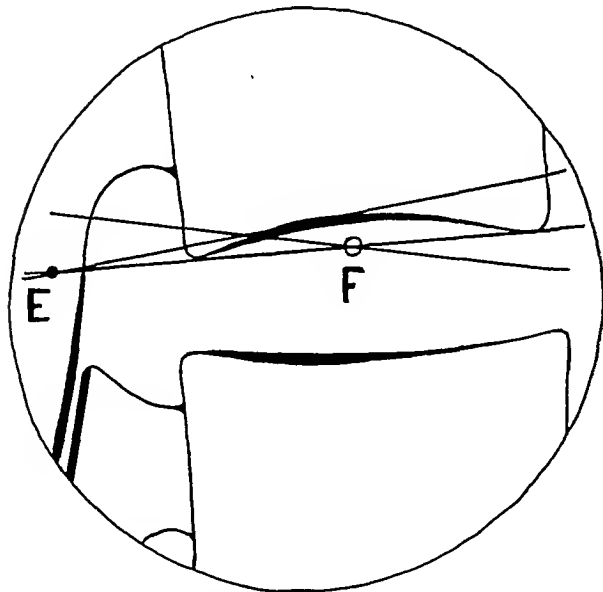


FIG. 8. Displacement of the fulcrum of extension to the level of the articular processes.

In 2 discs either the fulcrum of extension or that of flexion could be marked on roentgenogram A, but in the opposite movement, the vertebra above the disc moved up or down like a plunger so that the lines drawn at the lower edge of the body were parallel (Fig. 9).

In 2 disks there was such limitation of flexion that no fulcrum of flexion could be established.

In 2 discs there was no motion at all. Both of these discs were under partially sacralized fifth lumbar vertebrae.

The disc most frequently involved was the fourth lumbar disc.

Any attempt to explain abnormal vertebral motion must take into consideration

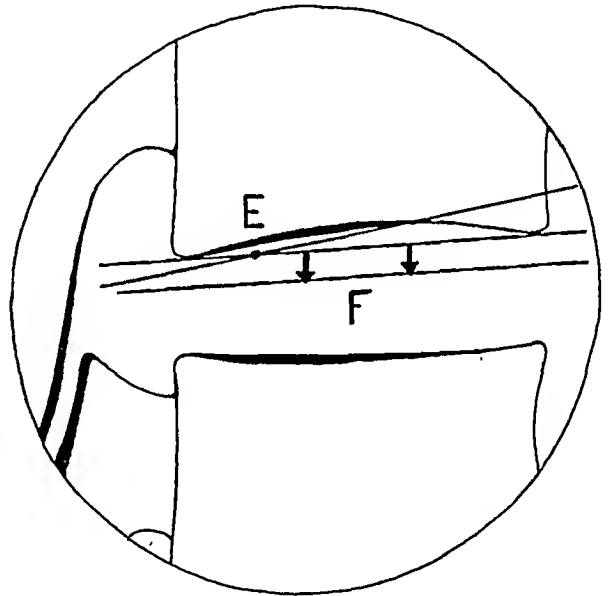


FIG. 9. Plunger type of flexion.

all the factors involved in the movements of the spine.

The first factor to be considered is that of muscular action. The only abnormality of muscular action noted was spasm. This was present in 4 of the 15 patients who showed abnormal motion, but in 2 of these 4 patients the muscle spasm disappeared following the administration of  $\frac{1}{2}$  grain of morphine half an hour before their examination. The 2 other patients still had some spasm at the time of the motion studies, but while one would expect muscle



spasm to affect the motion of all the lumbar vertebrae, in each of these patients only 1 disc was involved. It seems, therefore, that muscle spasm played no part in the production of abnormal motion.

The second factor to be considered is the effect of the bony lesions found in 7 of the 15 patients showing abnormal motion. Bone changes were certainly responsible for the lack of motion found in the 2 patients who had sacralization of the fifth lumbar vertebra, and for the abnormal motion found at the level of the lumbosacral disc of the 2 patients with spondylolisthesis. It must be noted, however, that in both patients with spondylolisthesis, there was abnormal motion also at higher levels (Fig. 10), and that this abnormal motion at higher levels cannot be explained by the lesion found at the lumbosacral junction. The effects of the bony lesions found in the remaining patients must also be critically evaluated. In the patient showing old osteochondritis, this condition affected the whole lumbar spine, but only the fourth disc showed abnormal motion. In the patient showing an old compression fracture, the abnormal motion was not at the disc adjacent to this fracture, but at a disc removed from it. It appears, therefore, that the abnormal motion in only 4 cases out of 21 can be attributed to the presence of bone lesions.

The third factor to be considered is the behavior of the posterior articulations of the spine. Recalling the stresses to which the articular facets are subjected during vertebral motion, it seems reasonable to assume that some damage to the sliding cartilages was responsible for the 2 instances in which there was posterior displacement of the fulcrum of extension to the level of the articular processes and, perhaps, for the 2 instances in which the motion was of a plunger type.

There remain 13 instances of abnormal motion in which an explanation must be sought in some changes involving the intervertebral discs.

In order to gain an understanding of how

changes in the intervertebral discs can affect motion of the spine, one must recall that their pathological conditions include the following: first, the normal aging process in which the nuclear substance gradually loses some of its water content;

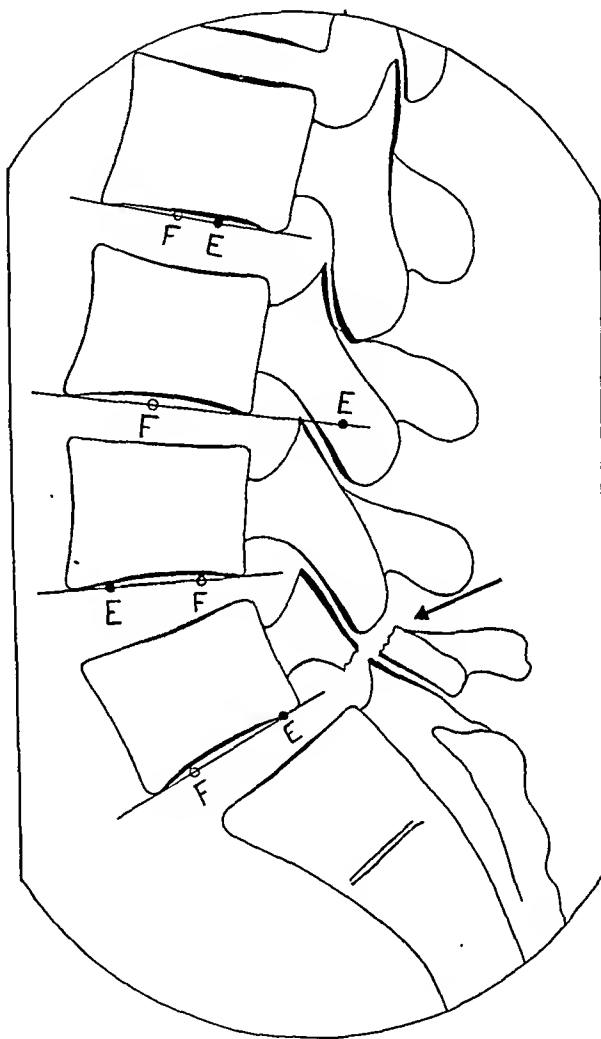


FIG. 10. Spondylolisthesis, grade 2; spread of the fulcrum at the fifth disc, spread and reversal of the fulcrum at the fourth, articular type of motion at the third, normal motion at the second lumbar disc.

second, the aseptic necrosis of the nucleus, which is also accompanied by loss of water; third, the herniation of the nuclear substance outside of the annulus. All these conditions are associated with loss of nuclear volume and this loss of volume, without a simultaneous shrinkage of the annulus, must result in lowering of the in-

tranuclear pressure. The aseptic necrosis and the posterior herniation of the nucleus are also accompanied by necrosis of the fibrils binding the nucleus to the vertebral bodies and this produces an increased mobility of the nuclear substance.

If one recalls the stresses to which normal nuclei are subjected during the movements of the spine, one must assume that a diseased nucleus will withstand these stresses rather poorly. The poor function of a diseased nucleus is probably responsible for the abnormal motion of the last 13 cases.

It is fully realized that a great deal of investigation will be necessary to establish the exact anatomical basis for the various types of abnormal motion. From a clinical

standpoint, however, one should note that abnormal motion was found in a high percentage of the patients who were examined because of low back pain.

It is hoped that the presentation of this method for the roentgen analysis of vertebral motion will stimulate further research in this field.

#### CONCLUSIONS

1. There is a definite pattern of vertebral motion in the lumbar spine of normal individuals and this pattern can be demonstrated by roentgen examination.
2. Various types of deviation from the normal pattern of motion were observed in a high percentage of the patients examined because of low back pain.



# NON-INJECTION METHOD FOR ROENTGENOGRAPHIC VISUALIZATION OF THE INTERNAL SEMILUNAR CARTILAGE

## TECHNIQUE AND ANALYSIS OF RESULTS IN 709 EXAMINATIONS

By MAJOR LEONARD LONG\*

*Medical Corps, Army of the United States*

THE positive and negative errors in the clinical diagnosis of injuries to the knee cartilages have been estimated at 15 per cent in one clinic (Schaer, quoted by Evans<sup>1</sup>). This undoubtedly is greater when the physician does not have special training or experience in orthopedics. It becomes of special importance in military medicine where such a diagnosis eliminates a man from combat duty and usually from the service entirely. The difficulty of arriving at a correct diagnosis in cases where the history is not reliable for one reason or another is obvious. Routine roentgenography of the knee is rarely helpful except in ruling out bone lesions and radiopaque loose bodies. Therefore, any diagnostic procedure which will eliminate some of these errors should be of great value, especially in military hospitals.

There has been considerable literature written on roentgenographic demonstration of the semilunar cartilages, mostly concerning injection methods with gas and radiopaque solutions. In military medicine these are considered operative procedures which may alter the line of duty status of subsequent developments and therefore would not ordinarily be used as a routine. A method which is nonoperative and simple enough to be performed routinely by a technician becomes of special interest and merits careful consideration.

We are using the method outlined by Reynolds<sup>2</sup> in 1941. Reynolds discovered that up to that time in most of those cases in which subsequent operation proved a pathologic condition of the internal cartilage he had not been able to demonstrate this cartilage in contrast to about 75 per

cent visualized in asymptomatic knees. This seemed to him to suggest that non-visualization by his method was evidence of a pathologic condition. Since then Reynolds has analyzed a series of 80 cases with surgical follow-up.<sup>3</sup> Of the 76 cases with cartilage pathology 6 (6.5 per cent) had been reported as normal and 10 (13.2 per cent) as indistinct by his technique. Our own series also proves that a pathological cartilage can be demonstrated at times but indicates also that in a large percentage of those cases a defect may also be visible or the contour of the shadow suggests dislocation (Fig. 4, 8 and 9).

The appearance of the internal cartilage with this technique logically should not differ greatly from that seen in the anteroposterior projection using air injection for contrast and so far as we can tell from the literature this is actually true. Simon, Hamilton, and Farrington<sup>4</sup> in 1936 (using air injection) state that air underlying the internal cartilage is always indicative of a pathologic condition but do not attempt to explain why it should be true. Since with Reynolds' technique a contrast shadow around the cartilage is very infrequent in the presence of a pathologic condition, it would be of interest to know what the results would be if, after air injection, anteroposterior views were made using abduction, traction, and internal rotation as in Reynolds' method.

The same authors list as diagnostic of a "bucket-handle" tear an "air replacement" shadow which separates the peripheral and internal portions of the cartilage. In those cases in which a pathological cartilage can be outlined by Reynolds' technique one

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would expect frequently to see similar findings. Our own series seems to confirm this.

The basic principles of the non-injection method are not new but very little has been written on the subject. Evans<sup>1</sup> in 1940 reviewed such literature to that date. Reynolds incorporated certain maneuvers which apparently have increased the accu-

Bucky diaphragm (Fig. 1). It consists of a piece of  $\frac{1}{4}$  inch plywood about 2 feet long and of width sufficient to fit inside the metal rails at the sides of the table top. If there are no rails on the table, a flange will have to be added to each side of the board to prevent side-play. In the center running lengthwise is a 5×16 inch opening, and midway on one side of this is a padded ful-

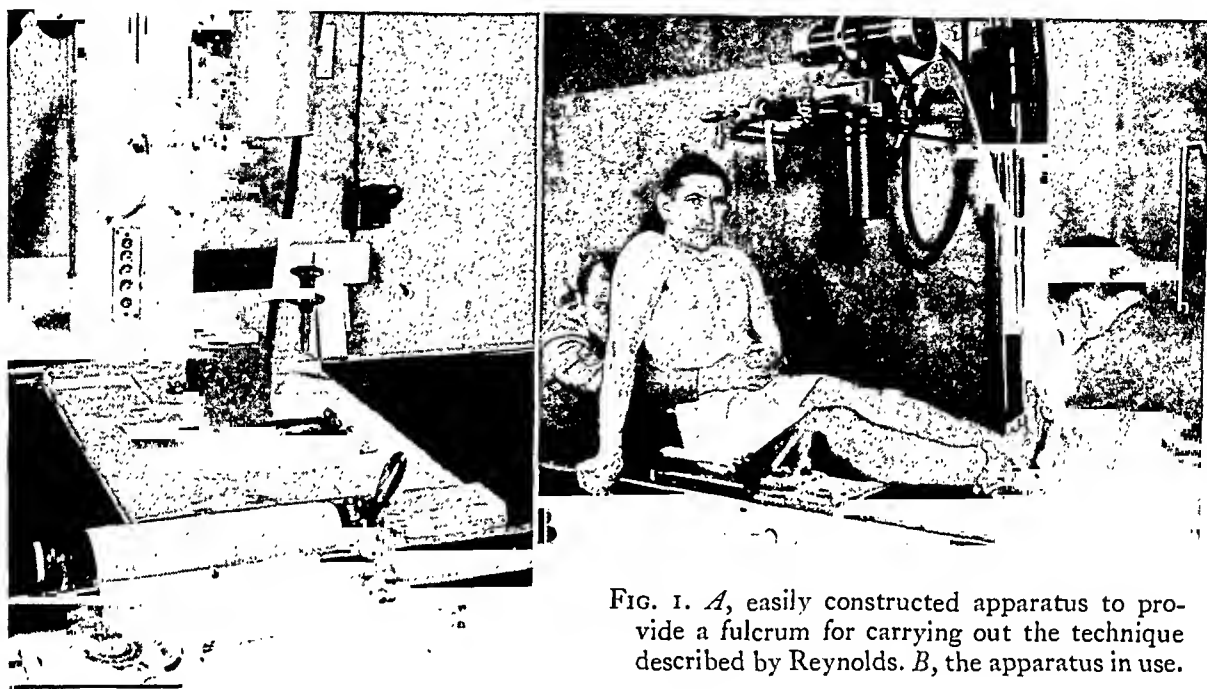


FIG. 1. *A*, easily constructed apparatus to provide a fulcrum for carrying out the technique described by Reynolds. *B*, the apparatus in use.

racy and at the same time kept the examination within the capabilities of a good technician.

#### TECHNIQUE

The technique consists essentially in making an anteroposterior exposure about three seconds after the end of a maneuver consisting of strong traction and firm internal rotation and abduction of the fully extended leg. The thigh is held tightly against the table by a strong immobilization band with a fixed padded fulcrum against its lateral aspect just above the knee. This fulcrum is very important and must be solidly fixed but at the same time easily removable and adaptable to either side of the table for right or left knee.

We have been successfully using a very simple and easily constructed accessory adaptable to any table with or without a

crum securely attached to the board. By simply turning the board end-for-end it may be used for either right or left knee.

The patient (shoe removed) sits at one end of the board with the knee to be examined fully extended over the distal part of the opening and the padded fulcrum against the lateral aspect of the thigh just above the knee. The compression band is brought across the thigh with strong tension. A wedge (the patient's hand works very well) is placed under the margin of the buttock opposite to the side being examined to prevent a tendency to slide during the abduction maneuver. Counter traction is arranged either by a band around the patient's pelvis and attached to the head of the table or (more easily) simply by having an assistant lean over the head of the table, reach around the patient's pelvis, and pull

just enough to keep the patient from sliding. The patient is urged to relax the thigh muscles. Film and tube in position with an assistant ready to make the exposure, the technician now grasps the patient's instep with one hand and the heel with the other and applies strong traction together with firm internal rotation and abduction of the leg, all in a single combination of motions. Almost immediately after completing the maneuver (about three seconds) he signals

in the hospital or out-patient department. Unfortunately, our hope for a substantial series with surgical follow-up could not be realized. However, the results based on clinical history and examination seem to be of value and may, we hope, stimulate interest where more frequent surgical follow-up is possible. Our cases fall into seven groups as follows (Table I):

*Group I.* Normal knees. In all cases in which only one knee was symptomatic the

TABLE I  
RESULTS OF EXAMINATIONS

	Cartilage Demonstrated	Cartilage Not Demonstrated	Totals
Group I—Normal, asymptomatic knees . . . . .	191 (67.2%)	93 (32.8%)	284
Group II—Symptomatic knees with final diagnosis other than pathologic cartilage . . . . .	75 (60.4%)	49 (39.6%)	124
Group III—Clinical diagnosis of pathologic cartilage without surgical follow-up . . . . .	12* (17.0%)	58 (83.0%)	70
Group IV—Probable pathologic cartilage but no definite diagnosis made . . . . .	0	41 (100.0%)	41
Group V—Symptomatic knees with records not available for classification . . . . .	18 (41.0%)	26 (59.0%)	44
Group VI—Previous knee operation elsewhere but no record as to exact procedure . . . . .	0	4 (100.0%)	4
Group VII—Pathologic cartilage with operative confirmation . . . . .	2† (13.3%)	13 (86.7%)	15

\* Eight of these showed a defect or thinning of internal portion.

† Both with a defect (Fig. 4 and 5).

for the exposure and, of course, avoids any movement at that time.

Suggested technical factors for an average size knee using par-speed screens and Bucky diaphragm are 40 inches target-film distance, 74 kv., 12 ma-sec., the central ray passing through the distal margin of the patella.

#### RESULTS OF EXAMINATION

This series includes a total of 709 examinations on 291 patients, all soldiers, during the year ending August 1, 1943. All had symptoms referable to one or both knees, more or less suggestive of a pathologic condition of the cartilage and these special studies were requested by various medical officers in charge of the cases during the course of their clinical observations either

normal knee also was routinely examined. There were 284 such asymptomatic knees and in 191 (67.2 per cent) of these the internal cartilage was outlined.

*Group II.* There were 124 cases in which the clinical findings proved to be negative for a pathologic condition of the cartilage in the case of the knee complained about. Of these, 75 (61.4 per cent) revealed the cartilage outlined in the roentgenograms.

*Group III.* Cases with a clinical diagnosis of cartilage pathology without surgical follow-up. In this group there were 70 cases of which 58 (83 per cent) did not show the cartilage and 12 (17 per cent) did show it. Review of the roentgenograms in these 12 cases reveals the cartilage shadow to be definitely abnormal in appearance in 8

TABLE II  
GROUP VII—CASES TREATED SURGICALLY

Case	Roentgen Examination with Special Technique	Report of Operation as Recorded	Pathologist's Report
1	Internal cartilage very well outlined on two examinations showing "air replacement" shadow of Simon <i>et al.</i> (Fig. 4)	Excision of left meniscus	Gross: a frayed portion of semilunar cartilage 6 cm. in length. Microscopic: cartilage and adjacent connective tissue
2	Internal cartilage very well outlined and showing "air replacement" shadow of Simon <i>et al.</i> (Fig. 5)	Loose medial cartilage	Gross: a portion of semilunar cartilage 6 cm. in length having smooth glistening surfaces. Microscopic: essentially intact fibrocartilage
3	Before operation no cartilage shadow was visible. After operation a fuzzy shadow in the position of the cartilage representing either a piece of cartilage not removed or an organized exudate (Fig. 3)	Rupture right internal cartilage, severe, bucket-handle tear	No tissue sent to the laboratory
4	Internal cartilage not demonstrated	Bucket-handle fracture, dislocation of medial internal semilunar cartilage; excised	Gross: a portion of semilunar cartilage 6 cm. in length which is torn along its entire length. Microscopic: well formed fibrocartilage showing a few scattered small areas of mucoid degeneration
5	Internal cartilage not demonstrated	Hemorrhagic fluid in joint, capsular tear internal femoral condyle not involving medial collateral ligament but lying adjacent to cartilage. Excision of internal cartilage	Gross: a semilunar cartilage 8 cm. in length. Its outer thickened border is somewhat ragged. Microscopic: essentially intact fibrocartilage
6	Internal cartilage not demonstrated	Split posterior third internal cartilage; excised	Gross: an irregular portion of semilunar cartilage 7 cm. in length. Microscopic: fibrocartilage showing extensive mucinous degeneration with cyst formation
7	Internal cartilage not demonstrated	Complete bucket-handle tear with displacement into middle of joint. Completely excised	Gross: an irregular torn piece of semilunar 7 cm. in length. Microscopic: dense fibrocartilage showing a few small foci of mucinous degeneration
8	Internal cartilage not demonstrated	Bucket-handle tear right internal cartilage	Gross: two irregular pieces of semilunar cartilage measuring 7 and 4 cm. in length respectively. Microscopic: dense fibrocartilage showing minute areas of mucinous change but an otherwise normal histological appearance

TABLE II—*Cont.*

Case	Roentgen Examination with Special Technique	Report of Operation as Recorded	Pathologist's Report
9	Internal cartilage not demonstrated	Bucket-handle tear right external semilunar cartilage. Excision of external cartilage	Gross: a torn irregular piece of semilunar cartilage 8 cm. in length. Microscopic: fibrocartilage showing extensive foci of mucinous degeneration
10	Internal cartilage not demonstrated	Excision of right internal cartilage	Gross: the specimen in 3 irregular portions showed only typical cartilaginous tissue. Microscopic: cartilage and adherent connective tissue
11	Internal cartilage not demonstrated	Loose mesial cartilage, left, removed complete and intact	Gross: a portion of semilunar cartilage 6 cm. in length. Microscopic: portions of fibrocartilage showing an essentially intact histological structure
12	Internal cartilage not demonstrated	Bucket-handle tear with displacement into middle of joint	Gross: a semilunar cartilage 6 cm. in length split along its middle portion. Microscopic: fibrocartilage showing occasional small foci of mucoid degeneration
13	Internal cartilage not demonstrated	Bucket-handle injury right internal cartilage	No tissue sent to the laboratory
14	Internal cartilage not demonstrated	Excision of right internal cartilage	No tissue sent to the laboratory
15	Internal cartilage not demonstrated	Bucket-handle tear left internal cartilage. Excision	No tissue sent to the laboratory

with either a defect and "air replacement" shadow or definite thinning of its internal portion (Fig. 8).

*Group IV.* Cases suspected of a pathologic cartilage but with no final diagnosis. There were 41 cases in the group and in none of them was the internal cartilage demonstrated. The clinical criteria for diagnosis are essentially the same as in Group III but because of lack of any follow-up no final diagnosis was ever entered in the record.

*Group V.* Cases with records too inadequate for any conclusion but who originally had knee complaints more or less suggestive of cartilage pathology. Of the 44 cases

in this group 26 (59 per cent) had no cartilage visible and 18 (41 per cent) showed the cartilage outline.

*Group VI.* Cases with previous operation elsewhere, presumably for a pathologic cartilage but not confirmed. None of the 4 had a cartilage visible in the roentgenogram. One of these (Fig. 2) had an irregular contrast shadow but no cartilage outline. Another case, which was operated here and is included in Group VII, had no cartilage visible before operation (Fig. 3, A). Six months after operation an examination (Fig. 3, B) reveals a wedge-shaped shadow almost like that produced by the cartilage though less sharply defined and quite blunt

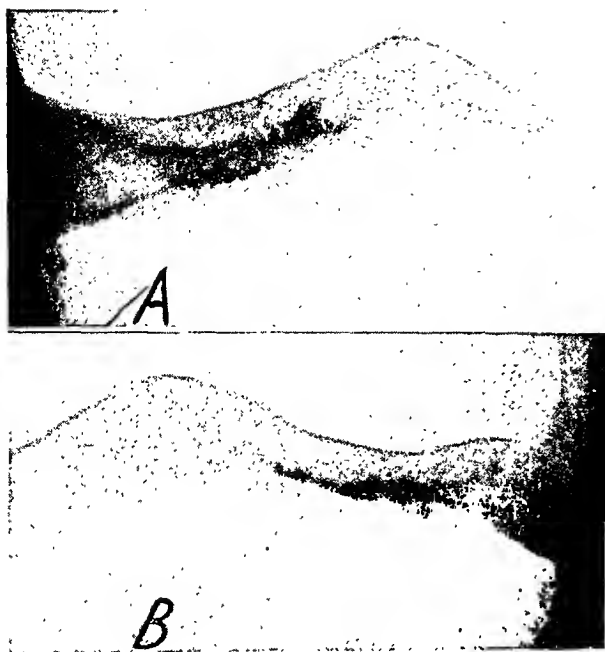


FIG. 2. *A*, asymptomatic right knee showing normal cartilage. *B*, left knee injured ten years ago at which time internal cartilage was removed. There is an irregular contrast shadow with no suggestion of a cartilage outline.

at its internal angle. The operative record states that there was a bucket-handle tear of the internal cartilage which was excised. No tissue was sent to the laboratory and no statement made as to how much of the cartilage was removed. If part of the cartilage adjacent to the capsule had been left, it might easily explain the apparent contradiction. An organized exudate in the space previously occupied by the cartilage is also a possible explanation though less probable. Reynolds<sup>3</sup> also had 2 cases showing what was interpreted as a normal internal cartilage shadow in which the cartilage had previously been removed.

*Group VII* (Table II). Cases operated for cartilage in this hospital. This group totaled 15 cases and 13 (86.7 per cent) of these showed no cartilage shadow in the roentgenograms with this technique before the operation. Two revealed distinct cartilage shadows (Fig. 4 and 5) and in both of these there was a defect conforming to the "air replacement" shadow. In neither case did the operative record indicate the type of injury found.

#### RESULTS OF RE-EXAMINATION

In 113 patients one or both knees were examined two or more times with a total of 125 examinations in addition to the first one. Table III shows the results at the second and third examinations for each of the seven groups.

There were 24 in which the cartilage was outlined in the original examination and all again showed it in the repeat studies.

Initially failing to show the cartilage, 40 asymptomatic control knees were rechecked and in 10 (25 per cent) it became visible. Six of the remainder were examined a third time and half of these then revealed the cartilage. If these percentages were maintained and all of the asymptomatic knees had been re-examined it would be expected that the percentage of success would increase from 67.2 per cent to 75.4 per cent with a second examination. Further improvement would follow a third trial but our series in this group is too small for accurate prediction.

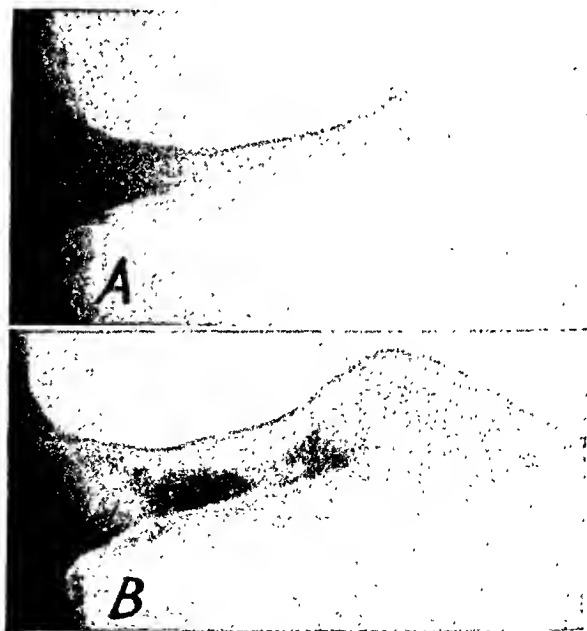


FIG. 3. *A*, Reynolds' technique showing no cartilage shadow. *B*, six months later after cartilage was surgically removed. Note irregular blunt rounded wedge without internal extensions which apparently represents an organized exudate or a piece of the peripheral portion of the cartilage not removed. Without the history correct interpretation would not be possible.



The symptomatic knees (Groups II to VII) included 49 with failure to show the cartilage on initial examination. Eight (16.3 per cent) became visible on second examination and 6 of these were in Group II in which the clinical findings were against

In attempting to explain why the initial examination fails and re-examinations succeed in so many cases we must admit that



FIG. 4. Cartilage injury with surgical confirmation. Note gap between peripheral and internal portions of cartilage, the "air replacement" shadow described by Simon, *et al.*, in their studies using air injection technique.

a pathologic cartilage. On the other hand, Groups III, IV, VI, and VII (definite or probable pathologic cartilage) had a change from non-visualization to visualization in only 1 out of 27 cases (3.7 per cent) and that one was on the third examination.

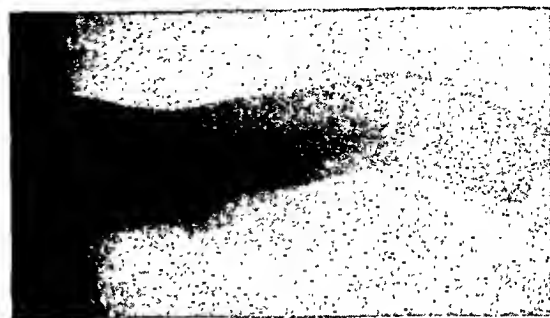


FIG. 5. Cartilage injury with surgical confirmation. Note "air replacement" defect near apex of cartilage wedge.

the experience of the technician making the examination is the most important factor but probably is not the only one. Perhaps some patients are less apprehensive and relax better after an initial experience has shown them what is to be done. Whatever it may be, we believe that in those cases in which the cartilage is not definitely outlined a second or even a third trial is justified.

TABLE III

RESULTS OF RE-EXAMINATIONS\*

	Second Examination		Third Examination	
	Cartilage remains not visible	Cartilage becomes visible	Cartilage remains not visible	Cartilage becomes visible
Group I—Normal, asymptomatic knees.....	30	10	3	3
Group II—Symptomatic knees but final diagnosis other than pathologic cartilage.....	9	6	2	0
Group III—Clinical diagnosis pathologic cartilage without surgical follow-up.....	15	0	2	1
Group IV—Probable pathologic cartilage but no definite diagnosis.....	8	0	0	0
Group V—Symptomatic knees but records not available for classification.....	6	1	0	0
Group VI—Previous operation but no record as to exact procedure.....	3	0	1	0
Group VII—Pathologic cartilage with operative confirmation.....	1	0	0	0

\* All cases in this table showed no cartilage shadow in the original examination. There were also 24 cases re-examined in which the cartilage was visible in both original and subsequent examinations.

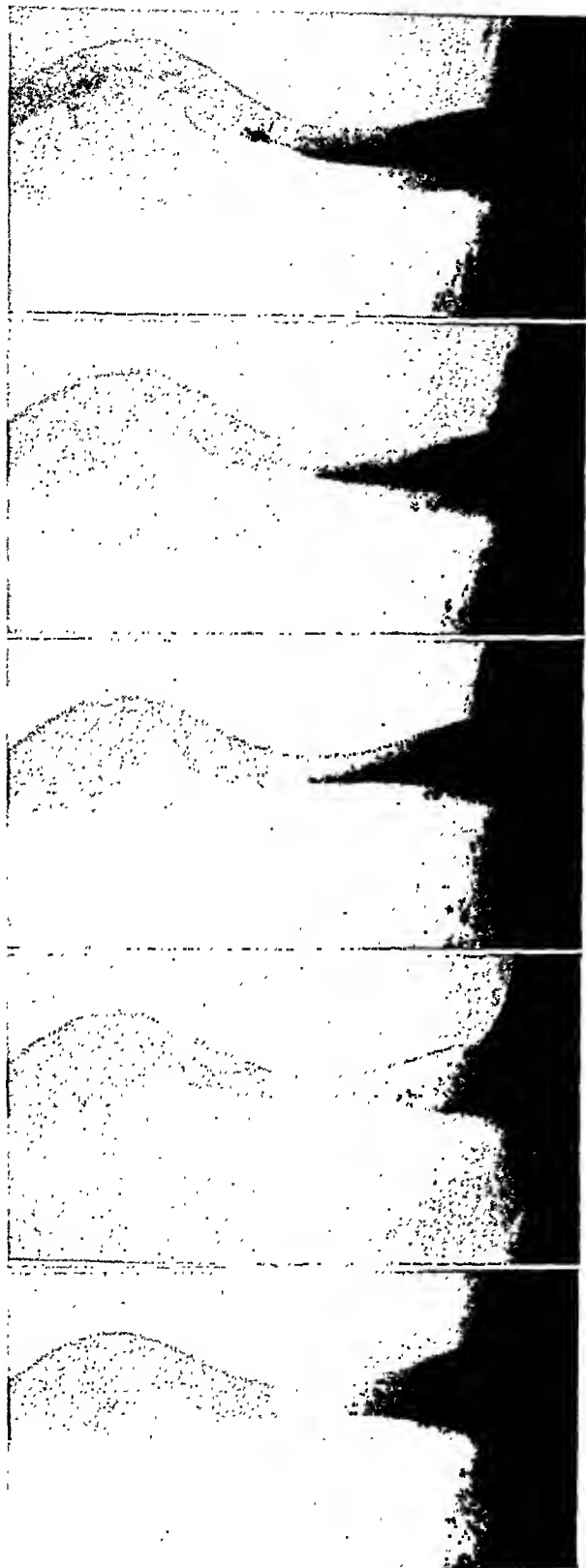


FIG. 6. Experiment demonstrating the gradual disappearance of the shadow and indicating that this shadow is a partial vacuum rather than air. The upper view was made immediately on completion of the maneuver as routinely performed in Reynolds' technique. The other four exposures were

#### DISCUSSION

Reynolds states that the cartilage cannot be demonstrated in the presence of effusion regardless of whether or not it is injured and this has also been our experience. Likewise acute tenderness is a contraindication and this should be allowed to subside completely. Otherwise the procedure is without ill effect and in itself causes no pain. It is conceivable, of course, that one could use too much force but none of our cases has complained of anything more



FIG. 7. Normal asymptomatic knees showing variation in the size and shape of the cartilage wedge. Note that either the anterior or posterior horn is projected over the tibia in all these cases. When the two horns are superimposed (as in Fig. 2, A) they will be unobscured by bone.

made respectively at one minute intervals, the traction, internal rotation, and abduction being maintained continuously.

than mild soreness over the mesial aspect of the knee for a few minutes afterward. One soon gets the proper "feel" and can easily tell when maximum abduction has been attained.

In order to determine if there is any importance in the time interval between maneuver and exposure we made a series of exposures in 1 case, the first almost immediately and 4 others at one minute intervals, all the while maintaining the traction, internal rotation, and abduction. The cartilage is sharply outlined in the first and the shadow progressively fades until at three minutes it is no longer visible (Fig. 6). Therefore, the shorter the interval the better, and we allow about three seconds for the patient and technician to become motionless.

This experiment also seems to settle the question as to whether the shadow is produced by air or vacuum. It seems unlikely that air would disappear so rapidly while, of course, vacuum would be expected to be replaced rapidly by the fluid normally in the joint. Abduction places the internal collateral ligament and capsule under tension and since the internal semilunar cartilage is attached to the capsule it is held in position midway between the separated articular surfaces of the tibia and femur allowing both its superior and inferior margins to be outlined. For this reason the air injection method of visualizing the cartilages might give more information if the anteroposte-

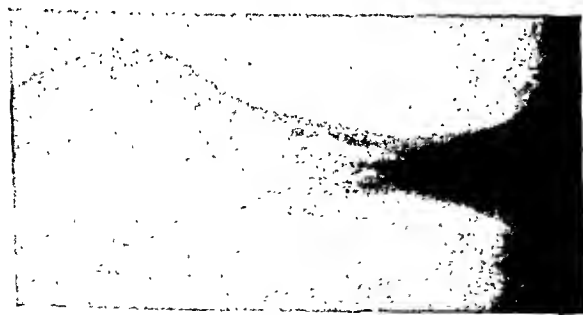


FIG. 8. Opposite knee of patient in Figure 3. Clinical diagnosis of a pathologic cartilage without surgical confirmation. Note irregularity of inferior cartilage border and thinning adjacent to peripheral portion suggesting "bucket-handle" tear.



FIG. 9. Clinical evidence of injury to internal cartilage. Note the mottled air shadow extending almost to the periphery with no cartilage outline visible. This appearance suggests severe injury with dislocation of the cartilage.

rior exposures were made using Reynolds' technique. I know of no instance in which this has been tried.

The normal cartilage varies somewhat in size in different individuals but is almost invariably identical in both knees of the same patient. The peripheral portion is wedge shaped with internal extensions representing the anterior and posterior horns very often clearly visible (Fig. 7).

Mottling of the contrast shadow occasionally occurs (Fig. 10) due to synovial fluid and is of no known significance. The cartilage can usually be seen quite well in spite of this though small defects are obscured. Also at times a contrast shadow is seen which is insufficient to outline anything (Fig. 11) and is of no diagnostic value.

Attempts were made to take lateral views but without success. This is to be expected when one considers the thinness and configuration that this contrast layer would present in this projection.

The external cartilage might be expected to become visible by reversing the maneuver from abduction to adduction. Evans was successful in 2 of 30 cases. Our own studies are exclusively of the internal cartilage.

As a result of the abduction necessary to carry out this technique there is separation of the internal femoral and tibial articular surfaces. This widening of the joint space varies considerably in different individuals

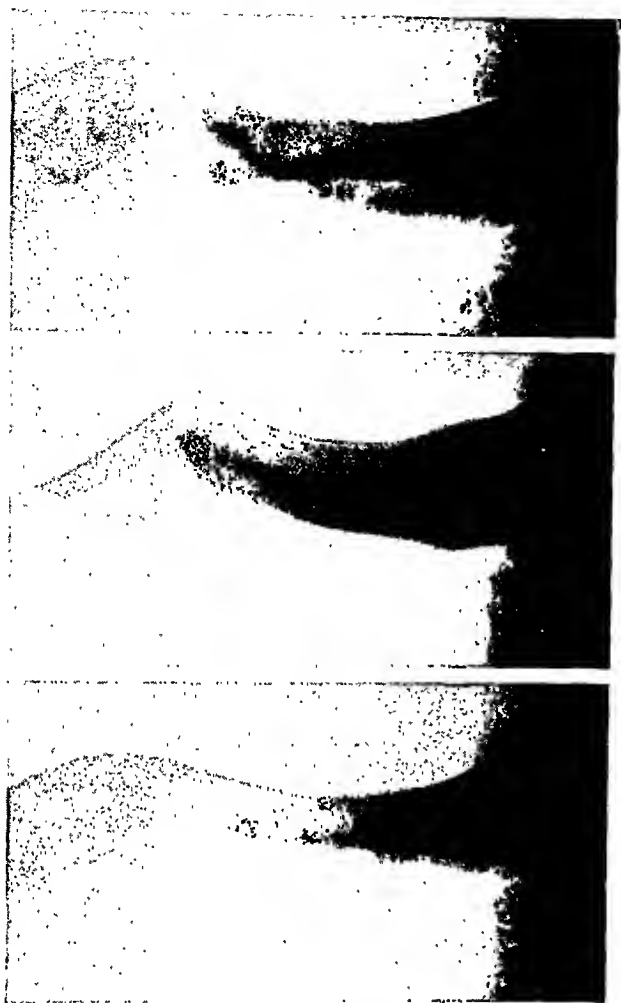


FIG. 10. Examples of mottling of the shadow apparently caused by synovial fluid. The cartilage is outlined but small defects could not be ruled out in these cases.

but is almost invariably equal in the knees of the same patient. In the case mentioned under Group VI and shown in Figure 3 it was noted that the space was greater after operation when the contrast shadow was present than before the operation when none was present. Thinking that a pathologic condition in the internal collateral ligament might be a factor in the success or failure of the technique we chose 50 cases at random and compared the joint space of the healthy knee in which the cartilage was demonstrated with the injured knee which revealed no cartilage shadow. This is best done by superimposing the two roentgenograms. No significant difference was noted. Likewise we have observed that increasing the amount of pressure above that

ordinarily used in abduction has little effect on the amount of separation or on the probability of demonstrating the cartilage.

Relaxation of the crucial and collateral ligaments may not be demonstrated in plain roentgenograms unless it is severe. In this series we have observed several cases in which it became obvious only with this technique and was manifested by unusual widening of the joint space and lateral shifting of the tibia (Fig. 12). This point is rather easy to determine from physical examination but it may be of value at times to be able to demonstrate it roentgenographically.

Likewise, narrowing of the lateral joint space may be more accurately portrayed by

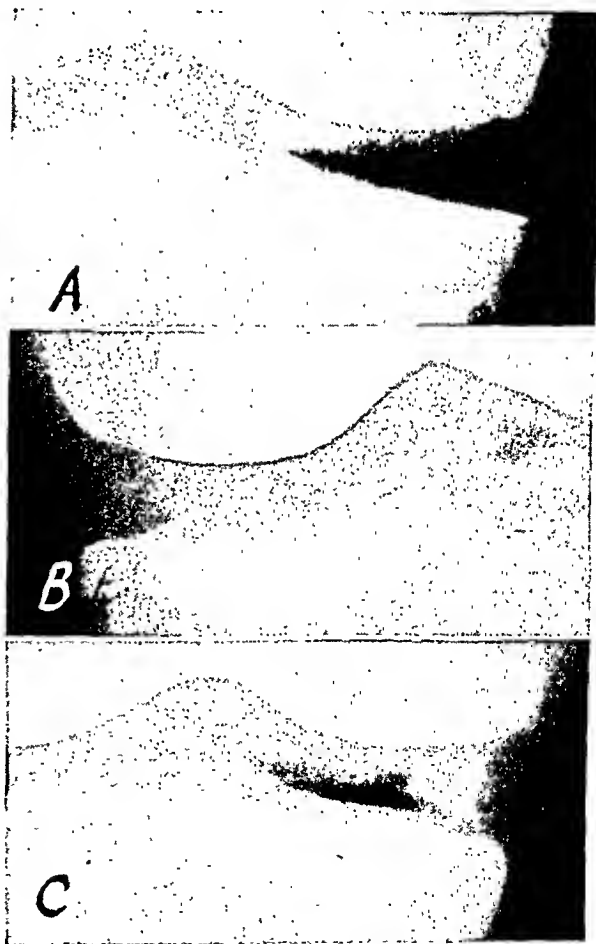


FIG. 11. Examples of shadows occasionally seen without the cartilage being outlined. The diagnostic value of such an appearance is no greater than if no contrast shadow is present. *A*, normal asymptomatic knee; *B*, clinical diagnosis of pathologic internal cartilage; *C*, suspected clinically of a pathologic condition of the cartilage.

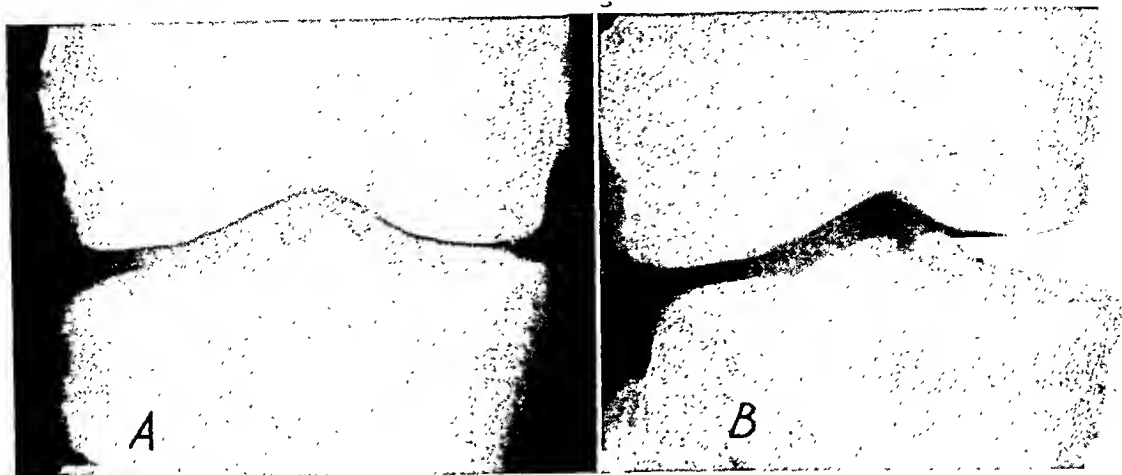


FIG. 12. Relaxation of ligaments. *A*, routine view showing only calcifications in the injured cruciate ligaments. *B*, Reynolds' technique demonstrating luxation of the tibia mesially and more than the usual separation of the mesial joint space.

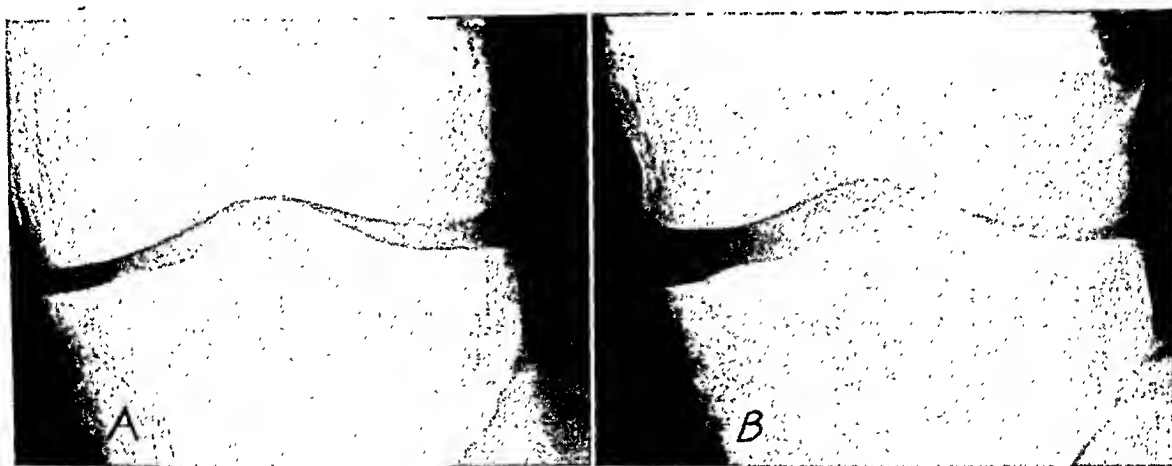


FIG. 13. Example of the value of Reynolds' technique in demonstrating thinning of the lateral joint space. *A*, routine roentgenogram; *B*, same knee using Reynolds' technique.

this technique as a result of the abduction than in ordinary roentgenograms (Fig. 13). This might be expected to occur when the external cartilage is dislocated or there is degeneration of the articular cartilage. Continued observation in this particular might add to the value of this technique, especially in cases of dislocation of the external cartilage.

#### CONCLUSIONS

1. The technique described by Reynolds for visualization of the internal semilunar cartilage requires careful attention to small details for success and should not be attempted after a recent injury.

2. In a series of 191 normal asymp-

tomatic knees 67.2 per cent revealed the cartilage on the first attempt. Re-examination increased this to 75.4 per cent.

3. In only 10.8 per cent of cases with diagnosis of a pathologic condition of the cartilage (mostly without surgical confirmation) could the cartilage be demonstrated. This indicates that non-visualization is of corroborative value.

4. When an abnormal cartilage is visualized the pathologic condition is often apparent as a defect, thinning, or absence of a distinct wedge (suggesting dislocation).

5. Thinning of the lateral joint space and relaxation of the ligaments of the knee may become apparent with this technique when

not demonstrated by routine views.

6. Improvement in accuracy of interpretation may be expected when a large series of surgically treated cases can be analyzed.

7. Since the procedure has none of the disadvantages of the injection methods its routine use when a pathologic condition of the internal cartilage is suspected gives promise of being of definite value. In the present state of our knowledge the findings should be interpreted with relation to the clinical evidence.

8. Use of this technique when making the anteroposterior exposures after air injection might improve the results of that method.

#### SUMMARY

The technique described by Reynolds for visualization of the internal semilunar car-

tilage without injection has been discussed in detail and a simple apparatus for use in connection with it has been described. The results of a series of 709 examinations have been analyzed and examples of normal and abnormal cartilages presented.

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# MARCH FRACTURE

## AN ANALYSIS OF TWO HUNDRED CASES

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MARCH fractures of the metatarsals have been encountered with increasing frequency in the armed forces and several short reports have appeared in the American and British literature in the past two years.<sup>1,7,16,17,20,22</sup> The clinical syndrome and roentgenologic appearance should be well known by now, and will be mentioned only briefly in this report. However, the mechanism by means of which these fractures occur, and the predisposing causes, if any, have been the subject of so much theorizing and speculation in the literature that the whole question is confused.

It is the purpose of this report to present the results of a study of 200 soldiers who sustained 220 march fractures of the metatarsals between May, 1941 and August, 1943. Nine of these cases have been previously reported.<sup>7</sup> Special attention will be given to possible predisposing causes. The various theories which have been advanced to explain the pathogenesis of march fracture will be discussed.

### CLINICAL FINDINGS AND ROENTGENOLOGIC APPEARANCES

The first symptom is usually a dull ache in the metatarsal area, gradually increasing in severity. Only occasionally is the onset abrupt. The pain is present only when the body weight is borne on the foot, and to minimize it, the patient walks with a limp. There is usually some edema of the dorsum of the foot and tenderness is localized to the site of the fracture. No crepitus is felt and active motion at the ankle joint or of the toes is not painful. Relief is obtained by rest and elevation of the foot. In most untreated cases the fracture heals without complication, but in such instances the foot remains tender and painful for many weeks. Rest in bed and local application of an ice

bag until the edema subsides, followed by the use of a metatarsal bar on the shoe when walking is resumed, will shorten the period of disability. This is especially true if treatment is begun soon after the onset of symptoms. The experience of the orthopedic department at this hospital indicates that treatment by a plaster cast is not necessary and even delays the soldier's return to full duty. Some of the earlier cases in this series, which were treated with a plaster cast, developed osteoporosis.

One of us<sup>7</sup> has previously suggested that this syndrome may be divided into four stages, based on the roentgenologic findings. In the first stage, during the first seven to ten days after the onset of symptoms, the roentgenogram may reveal no abnormality or only a narrow and incomplete fracture line. Such a fracture may be missed entirely unless the roentgenogram is of excellent quality and is carefully studied. However, in many instances the fracture line is complete, and occasionally is actually comminuted. A fracture line can be demonstrated prior to the appearance of callus formation in almost all patients who are seen soon after they first experience the pain.

In the second stage, usually from one to three weeks after the onset, a loosely calcified, faint, fuzzy callus is seen surrounding the metatarsal in the shape of a spindle. The break in the cortex is almost always visible in this stage. The amount of callus is often out of proportion to the extent of the fracture, but if the fracture is recognized early and weight bearing is prohibited, the subsequent callus formation will be less abundant. If the fracture remains incomplete, the callus may be confined to one side of the shaft.

The third stage reveals the callus to be

more dense, more sharply circumscribed and of smaller volume. The fracture line is frequently still seen. This stage is usually seen two to six weeks after the onset.

The fourth and final stage is represented by diffuse thickening of the cortex of the metatarsal after several months have elapsed.

#### REVIEW AND ANALYSIS OF THE THEORIES ADVANCED IN THE LITERATURE

All recent papers credit Breithaupt with first describing this syndrome in 1855. He believed that "march foot" was a traumatic inflammation of the tendon sheaths. In 1877 Weisbach<sup>21</sup> thought that march foot was due to a traumatic inflammation of the intermetatarsal ligaments. In 1887 Pauzat<sup>13</sup> stated that a periosteal proliferation was present as the result of irritation from the dorsal fold of the French military shoe. One year later Poulet<sup>14</sup> suggested that a rheumatic diathesis was the underlying cause and in 1891 Martin<sup>8</sup> called it a synovitis and arthritis of the joints of the foot. All of these theories were discredited when, in 1897, Stechow<sup>18</sup> demonstrated roentgenologically that a fracture was present in some of these cases. Schulte<sup>15</sup> in the same year presented similar evidence. Since that time practically all writers have agreed that a fracture is the cause of the symptoms, and speculation then turned to the mechanism by means of which these fractures occurred.

Momburg,<sup>10</sup> in 1904, suggested that an inflammatory change occurred as the result of prolonged elastic bending of the metatarsals. This, he believed, caused periosteal proliferation, which, if continued, resulted in a fracture. Thus, Momburg believed that the periosteal proliferation preceded the fracture.

In 1905 Kirchner<sup>6</sup> stated that a fracture of a metatarsal was always present in these cases. He attributed the fracture to exhaustion of the intrinsic muscles of the foot and the consequent loss of their supportive action. The rôle of the intrinsic muscles of the foot in supporting the metatarsals has

been the subject of considerable study by Morton.<sup>12</sup> His carefully worked out evidence indicates that these relatively weak muscles have no significant part in metatarsal support. This theory of Kirchner's is not valid in the light of the evidence offered by Morton.

In 1921, Deutschländer<sup>3</sup> advanced the idea that the basic process in march foot was a low grade hematogenous bacterial periostitis. He based his reasoning on 6 cases, all in women. In these patients periosteal proliferation was present only after a period of several weeks. This theory offers no explanation for the location of the pathologic process. The second or third metatarsal was involved in all 6 of his cases. If this is an embolic phenomenon, as Deutschländer maintained, this localization cannot be explained on the basis of the blood supply to the foot. Furthermore, in one of his illustrations there appears to be a fracture line, and the author admitted that from roentgenologic evidence alone, the entity he described was practically indistinguishable from the march foot of soldiers. There appears to be no valid evidence to sustain the infectious theory as a cause of march fracture.

In 1926 Jansen<sup>5</sup> proposed the circulatory theory. He noted that bony changes occurred only in the areas where the fibers of the interossei arise (i.e., all of the metatarsals except the first and the lateral border of the fifth). He theorized that overfatigue in a weak forefoot causes spasm and swelling of the interossei, stasis of the blood and lymph, thickening of the periosteum and brittleness of the bony tissue of the metatarsals. He believed that subperiosteal hemorrhages occur, are followed by partial absorption of bone and that the bone is weakened by an internal reorganization of its structure and that eventually a fracture occurs.

There are several objections to this theory. First, the explanation for the site of the fracture is unnecessarily complicated. More simply explained, it would appear that the fifth metatarsal is spared because it



bears only a small portion of the body weight in walking. The first metatarsal is not fractured because its heavier structure enables it to withstand the trauma of marching. Second, we have never seen absorption of bone on the roentgenogram before the appearance of the fracture. Dodd<sup>4</sup> has made a similar comment. Third, Jansen's explanation of the mechanism, as does Momburg's, attempts to explain the fact that, at that time, the fracture was rarely demonstrated until periosteal proliferation was seen, and frequently never was demonstrated. This theory supposes that the periosteal proliferation precedes the fracture and indeed that a fracture may not occur in all cases. More recent reports, especially that of Meyerding and Pollock<sup>9</sup> and our own present experience, refute this. The fracture occurs first, and the periosteal reaction which has been so stressed in the earlier literature is simply callus formation. The explanation for the earlier opinion that the periosteal proliferation precedes the fracture probably lies in the technical advances in roentgenography which have enabled the production of roentgenograms of a degree of definition and detail beyond that obtainable at that time. Many fine "hair line" fractures undoubtedly were not visible. It thus appears that the circulatory theory was advanced to explain a sequence of events which has since been shown to be incorrect. Certainly no theory of muscular swelling and venous stasis is necessary to explain a fracture of a metatarsal.

More recently Dodd<sup>4</sup> in 1933, Zeitlin and Odessky<sup>23</sup> in 1935, and Sirbu and Palmer<sup>16</sup> in 1942 have attempted to explain the cause of the fracture on the basis of the disturbed weight bearing incident to a short first metatarsal, the so-called "Morton's foot."

Morton<sup>12</sup> has described a group of four variations from the normal foot, visible roentgenologically, which have become known by his name. These are (1) a short first metatarsal, (2) proximal location of the sesamoids of the first metatarsal, (3) widening of the joint space between the

first and second cuneiforms and (4) thickening of the shaft of the second metatarsal. He regarded such a foot as functionally inadequate because when these changes are present the first metatarsal does not bear its proper share of the body weight. As a result, the load is thrown on the other metatarsals, especially the second. Morton explained, and has successfully treated, many cases of metatarsalgia on this basis.

The sesamoids act as weight-bearing points. If they are located proximally (even when the first metatarsal is of normal length) so that they lie behind the head of the second metatarsal, then the same functional effect is achieved as if the first metatarsal itself is shortened. Morton's foot is therefore regarded as occurring in two forms, the "anatomically" short first metatarsal and the "functionally" short first metatarsal, each of which has the same significance. The separation between the cuneiforms is extremely difficult to evaluate roentgenologically, since the slightest variation in the direction of the central ray causes a marked variation in the appearance of the joint space. (For this reason no attempt was made to evaluate this point in the present study.)

Dodd<sup>4</sup> reported a single case which was erroneously diagnosed as sarcoma (an error others<sup>19</sup> have made). He also reviewed the roentgenograms of 14 published cases, including his own, for the presence of Morton's four points. These he found to be present, at least in part, in every case. He therefore concluded that march fracture is "an autotraumatic complication of subacute flat-foot in an architecturally weak (Morton's) foot."

Zeitlin and Odessky<sup>23</sup> also supported the idea that the cause of the fracture was a displacement of the body weight towards the midline of the foot by the anatomic conditions and structure of a weak (Morton's) foot. They favored the name "pied surchargé" indicating an overloaded foot.

Sirbu and Palmer<sup>16</sup> reported 15 cases of march fracture, every one of which had an anatomically or functionally short first met-

atarsal. They stated that the disturbed weight-bearing which resulted from a short first metatarsal was the basic cause of march fracture. This theory will be discussed together with the presentation of the results of the present study, and will be shown to be erroneous.

Moore and Bracher<sup>11</sup> reported 3 cases in 1941. They stated that "Fatigue, overweight, underdevelopment and functional disorders of the foot do not seem to be the underlying causes of this fracture." Although based on only 3 cases, their conclusions are generally substantiated by the findings in the much larger series reported at this time.

The exciting cause of these fractures is an overloading of the bone by rhythmically repeated, subthreshold traumata acting by summation, beyond the ability of the bone to withstand the stress.<sup>2</sup>

It is well known that metals will crack under certain stresses as the result of changes in the crystalline structure. Henschel (quoted by Brandt) studied the fine structure of bone with the spectroradiograph (a method used in metallurgy to study the crystalline structure of metals). He found that in bone, as in "stressed" metals, changes occur in the grouping of the crystalline systems. If the stress continues, cracks or exhaustion fractures may occur. So far as we have been able to determine, no other worker has reported similar studies.

An important fact was brought out in the examination of the soldiers in this series. Many patients volunteered the information that the onset of pain occurred toward the end of a long march. The constant pounding to which the feet are subjected in such long marches is accentuated by fatigue of the calf muscles. It is almost impossible to maintain the same easy stride and springy gait in the twentieth mile as in the first mile, especially when carrying a pack and rifle. The fracture is essentially a fatigue injury, which appears to be best explained on the basis of Henschel's experiments.

What is probably more important, es-

pecially from the standpoint of possible prevention, is the question of predisposing factors. It is this problem which has absorbed our major interest.

#### MATERIAL STUDIED AND THE METHOD USED

Two hundred consecutive patients with one or more march fractures, examined at this Station Hospital, comprise the group studied. They ranged in age from eighteen to fifty-one, but 81 per cent were between eighteen and twenty-nine years old. So far as possible, the following information was noted in every case:

- Age of the patient
- Length of service prior to the onset of symptoms
- Occupation before induction
- Branch of service
- Site of the fracture
- Stage of the fracture when first seen
- Body build (slender, medium, heavy)
- Length of the first metatarsal in relation to the second
- Location of the sesamoid bones of the first metatarsal
- Presence of thickening of the cortex of the second metatarsal
- General structure of the foot (slender, average, broad)
- Abnormalities of foot structure or evidence of systemic disease

A control group consisting of the roentgenograms of the feet of 400 soldiers was studied. These were selected from the files on the basis of a single criterion. That is, that they were the roentgenograms of soldiers who had the misfortune to suffer a single injury of such severity that the examining medical officer suspected a fracture, and had therefore ordered a roentgen examination. These roentgenograms were not inspected before they were selected for the control group, but were chosen from the files solely on the basis of the statement of the examining officer (on the "x-ray request form") that a single injury had been sustained. Of these 400 soldiers, 165 actually had a fracture due to that single trauma; the remaining 235 did not. This control group is composed of soldiers of essentially

the same age and stage of training, and are drawn from the same military organizations as the march fracture group. The only difference is the manner in which the injury occurred. Such a group is neither more nor less likely to have abnormal feet than the average run of soldiers in the same organizations, and was therefore deemed a true control.

The same roentgenographic technique was used throughout. Dorsoplantar and oblique roentgenograms were made at 36 inch distance, employing a small focal spot and a cardboard film holder. Additional views were made as indicated.

#### RESULTS

(a) *Length of Service.* The length of service prior to the onset of symptoms varied from one month to seven years and ten months, but 80 per cent of the fractures occurred during the first six months of service. The mode, which represents the typical case, was the three to four month group. Since approximately one month is consumed by the initial furlough granted to selectees at the time of this study, and by the time needed to process them, to transport them to their place of duty and to organize them into units, it is evident that the typical patient had only two or three months' training at the time of the onset of the pain.

Ten soldiers had been in the regular army for over twenty months. In most of these instances, questioning revealed that the soldier had been recently transferred from a sedentary job to an organization undergoing intensive training.

(b) *Occupation Prior to Induction.* In every case an attempt was made to determine the amount of walking or standing the individual's job had required. These were then classed as sedentary or active in relation to the amount of strain the feet had been accustomed to in the past. Excluding the Regular Army soldiers, 44 per cent had pursued a vocation which had required much standing or walking, and 56 per cent had followed a sedentary occupa-

tion. Thus it is seen that the occupation prior to induction has no relation to the occurrence of a march fracture.

There are several reasons for this. The strain placed on the feet in military service is entirely different from that experienced in civil life. Even those who have arduous jobs in civil life can almost always sit down and rest for a few minutes when they become fatigued. Furthermore, a farmer does most of his walking on relatively soft soil, whereas a soldier does much of his marching on roads or hard drill fields. There is also the added factor of the pack and rifle which materially increase the weight the feet have been accustomed to bearing.

(c) *Branch of Service.* The great majority of the soldiers in this series were infantrymen, a percentage which was much higher than the average proportion of infantry troops present on the post. This is not surprising, since in spite of the mechanization of the modern army, the infantryman is still primarily a foot soldier.

(d) *Site of the Fracture.* The right foot was the site of the fracture in 105 instances, the left in 86 and both feet in 9 cases. In all bilateral cases the fractures occurred at different times. Fractures of more than one metatarsal in the same foot were present in 9 soldiers, in some cases apparently having occurred at the same time. Two patients had two metatarsals fractured in one foot and one in the other. Thus a total of 220 fractured metatarsals was seen in these 200 patients. These were distributed among the metatarsals as follows:

SITE OF THE 220 FRACTURES

	Number	Per Cent
Second metatarsal	98	44
Third metatarsal	112	51
Fourth metatarsal	10	5
Total	220	100

This is a somewhat higher percentage of fractures in the third metatarsal than has been noted in most previously reported



FIG. 1. Left foot, oblique view. A narrow, incomplete fracture line is visible (arrow) in the distal portion of the third metatarsal. No callus is present. This is a march fracture, first stage.

series. No fractures were present in the first and fifth metatarsals.

(e) *Stage in Which First Seen.* At the time of the first roentgenographic study the fractures occurred in the various stages as follows:

STAGE IN WHICH FIRST SEEN

	Number	Per Cent
No fracture diagnosed	25	11
First stage	113	52
Second stage	57	26
Third stage	25	11
Total	220	100

All of the patients on whom no diagnosis of a fracture was made on the first examination were re-examined within a few days because of continued pain, and the fracture was then discovered. The original roentgenograms were reviewed in every case and it was agreed that the diagnosis could have been made, or at least suspected, in 10 in-

stances. In the remaining 15 roentgenograms (7 per cent of all fractures) there was no evidence of a pathologic process even when the site of the fracture was known. It is possible that in some of this latter group the fractures had not yet occurred at the time of the original examination.

When first seen the fractures varied in extent from a barely visible hair line to easily seen complete fractures; 16 of these were comminuted.

(f) *Body Build.* It was possible to estimate the body build in 198 cases. These were distributed as follows:

BODY BUILD  
198 Cases

	Cases	Per Cent
Slender	67	34
Medium	92	46
Heavy	39	20
Total	198	100

Since this does not vary strikingly from the distribution found in any group of young males, it seems that march fractures occur without relation to the body build.

(g) *Short First Metatarsal.* In every instance of bilateral fracture the feet were symmetrical. Therefore, in such cases only one foot was counted for the purpose of estimating the incidence of a short first metatarsal.

According to Morton, the weight-bearing axis of the foot during walking or running is a line midway between the first and second metatarsals. A line drawn tangential to the distal tip of the first metatarsal, and perpendicular to this axis should normally cross the second metatarsal within 3 mm. of its distal tip. Therefore, the first metatarsal was considered to be "anatomically" short if such a line was 3 mm. or more proximal to the distal tip of the second metatarsal. The sesamoids were considered as proximally located ("functionally" short first metatarsal) if a transverse line through the center of the more distal sesamoid fell behind the entire head of the second meta-

tarsal. (These criteria were suggested to us by Morton.)

The incidence of a short first metatarsal among the march fracture patients and a comparison with the control group is as follows:

INCIDENCE OF SHORT FIRST METATARSAL

	March Frac- ture Cases 200 feet		Control Cases 400 feet	
	Feet	Per Cent	Feet	Per Cent
Anatomically short first metatarsal	42	21	103	27
Functionally short first metatarsal	60	30	81	19
Total	102	51	184	46

This is far short of the 100 per cent incidence reported by Dodd and by Sirbu and



FIG. 3. Left foot, dorsoplantar view. There is a spindle of loose, thinly calcified callus, with fuzzy margins, around the distal portion of the third metatarsal (arrows). The fracture line can be seen only with difficulty. This is a march fracture, second stage. It is this type of abundant callus which in the past has led to erroneous diagnoses of neoplasm. Note that the mid-points of the sesamoids (retouched for reproduction) are on a plane which falls behind the head of the second metatarsal, although the shaft of the first metatarsal is of normal length. This is an example of a "functionally" short first metatarsal.

Palmer. In addition, there is no significant difference in the frequency of occurrence of a short first metatarsal between the march fracture and the control group. From these figures it is concluded that a short first metatarsal is not a predisposing cause of march fracture.

At first glance, the percentage of a short first metatarsal (46 per cent) in the control group may seem high. However, Morton<sup>12</sup> stated that "... short or unstable first metatarsal bones are to be found in many feet that have never sensed any related discomfort ... nevertheless these factors must be classed as potential causes of foot disability ..."



FIG. 2. Right foot, oblique view. A comminuted fracture of the distal portion of the third metatarsal is present (arrows). This is a march fracture, first stage, comminuted. It is representative of 16 such fractures encountered in this series.

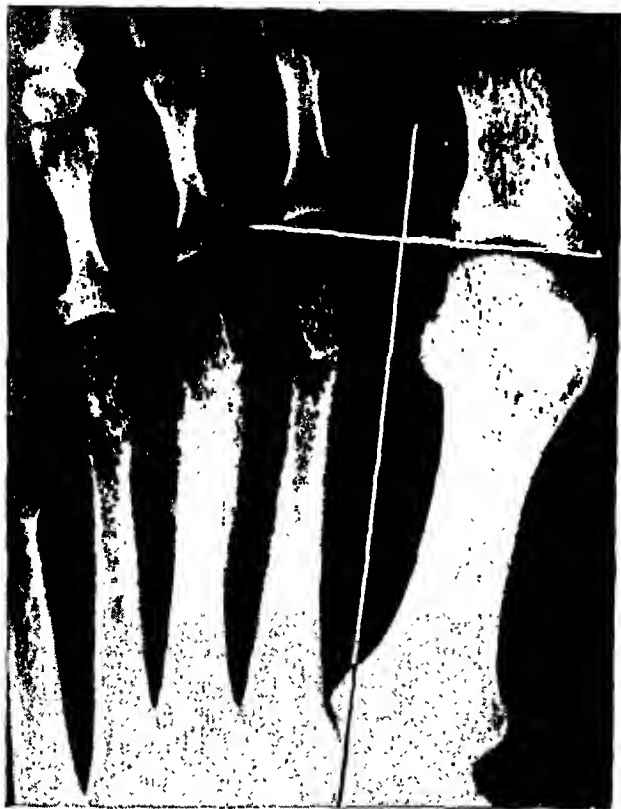


FIG. 4. Right foot, dorsoplantar view. A spindle of dense, sharply circumscribed callus is seen around the distal portion of the shaft of the third metatarsal. The fracture line is no longer visible. This is a march fracture, third stage. The line drawn between the first and second metatarsals represents the weight-bearing axis in the act of walking (Morton). A line drawn tangential to the tip of the first metatarsal, perpendicular to this axis, shows that the first metatarsal is of normal length. The foot is slender in relation to its length. The cortex of the second metatarsal is thickened in comparison with that of the fourth metatarsal.

As further confirmatory evidence of the absence of any relation between march fracture and a short first metatarsal, the location of the march fractures in those cases with a short first metatarsal was compared with the distribution among the men who had a normal first metatarsal, as follows:

EFFECT OF PRESENCE OF SHORT FIRST METATARSAL ON SITE OF FRACTURE		
Location of 220 Fractures	Short First Metatarsal Present	Normal First Metatarsal Present
Second metatarsal	46%	42%
Third metatarsal	51%	50%
Fourth metatarsal	3%	8%
Total	100%	100%

It is evident that the presence of a short first metatarsal has no material effect on the site of the fractures. A short first metatarsal is presumed to throw a greater proportion of the load on the second metatarsal. Therefore, if there is any relation-

ship between a short first metatarsal and march fracture, one would expect a greater proportion of such fractures to occur in the second metatarsal when a short first metatarsal is present. However, the table presented demonstrates that the location of these fractures is not significantly affected by the presence of a short first metatarsal. This fact further supports the conclusion that a short first metatarsal is not a predisposing cause of march fracture.

(h) *Thickening of the Cortex of the Second Metatarsal.* The cortex of the midportion of the shaft of the second metatarsal was compared with the corresponding area on the fourth metatarsal. On this basis, the occurrence of thickening of the cortex was as follows:

THICK CORTEX, SECOND METATARSAL		
	March Frac- ture Cases 200 feet	Control Cases 400 feet
Overall incidence	83%	79%
Of those with a short first metatarsal	87%	89%
Of those with a normal first metatarsal	80%	70%

Thickening of the cortex of the second metatarsal is thus seen to be very frequent. This higher incidence in those feet which have a short first metatarsal bears out Morton's idea of the relationship between the two. Morton has suggested that when the cortex of the second metatarsal is thickened, in the absence of a short first meta-



tarsal, then it is likely that hypermobility of the first metatarsal (separation between the first and second cuneiforms) is present. However in 70 per cent of our control cases with a normal first metatarsal there was some thickening of the cortex of the second. This seems rather high to be explained on this basis alone. There may be some relation to the presence of foot strain over a period of years. In general, the presence of a thickened cortex of the second metatarsal is so common that it must be regarded as the usual, if not the normal picture.

(i) *Width of the Foot.* This was assessed empirically, i.e., no absolute measurements were made. Each roentgenogram was viewed in an attempt to decide whether the foot was narrow in relation to its length. In such cases the metatarsal shafts were almost uniformly narrower than in the average run of feet. Of the 200 feet in the march fracture group 44, or 22 per cent, were considered to be of the slender type. The remainder were of average or greater than average width. In the control group of 400 feet only 15.5 per cent were considered to be of the narrow type. This difference is probably not significant.

(j) *Other Findings.* Seven cases of mild or moderate hallux valgus and 6 instances of hypertrophic spur formation at the distal end of the first metatarsal were encountered. An occasional case with mild or moderate pes planus and 3 with pes cavus were seen. There were no instances of osteoporosis nor was there evidence of any systemic disease such as rheumatoid arthritis or gout. All of the patients appeared to be well nourished.

#### SUMMARY

The clinical syndrome, the roentgenologic appearance and the treatment of march fracture have been briefly presented. The literature has been reviewed, and the many theories advanced to explain the pathogenesis of march fractures have been discussed and their shortcomings noted.

The immediate cause of the fracture is



FIG. 5. Left foot, slightly oblique view. There is a tiny cap of callus on the medial side of the distal portion of the second metatarsal (arrows). A tiny, incomplete fracture line is present under this callus. This is representative of the second stage, in which the fracture has remained incomplete, and the callus is confined to one side of the shaft. The first metatarsal is clearly seen to be "anatomically" short.

the rhythmically repeated, subthreshold traumata incident to marching, which, acting by summation, reach a point beyond the ability of the bone to bear stress. Fatigue of the calf muscles causes these subthreshold injuries to be accentuated. Henschel's experiments indicate that as the result of these subthreshold traumata a change in the crystalline structure of bone occurs. If the stress and strain is continued, a fracture occurs.

The results of the study of 200 soldiers with 220 march fractures of the metatarsals are reported. A control group of 400 cases was also studied.

These fractures usually (80 per cent) occur within the first six months of training, especially among infantrymen. The second and third metatarsals are most frequently

involved. One-half of the fractures are seen and can be diagnosed before callus formation occurs. The fractures vary in extent from a narrow "hair line" to actual comminution. A small proportion (7 per cent) cannot be diagnosed on the first examination but will be apparent on re-examination after a few days. Careful study of technically perfect roentgenograms is a requisite.

The nature of the soldier's previous occupation and his body build have no relation to the cause of march fracture. The presence of a short first metatarsal is not a predisposing cause. A slender foot (in relation to its length) does not appear to be a significant predisposing cause.

### CONCLUSIONS

1. There appears to be no single factor which occurs with sufficient regularity to be considered a predisposing cause of march fracture.

2. The presence of a short first metatarsal is not a predisposing cause.

3. While the actual exciting cause of the march fracture is apparent, none of the theories advanced in the literature adequately explain the pathogenesis, with the exception of Henschel's statement that a change in the crystalline structure of bone occurs under continued low grade stress. This is a fatigue fracture.

4. These fractures will continue to occur in the course of training soldiers. The most important fact to be emphasized is that early recognition and proper conservative treatment restore these men to duty with a minimum of lost time.\*

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\* Since this paper was submitted for publication, we have seen 46 additional cases with a total of 50 march fractures. Thus, the total number studied is now 246 soldiers, who sustained 270 fractures. The statistics presented and the conclusions drawn have not been altered by the additional cases seen.



# PEPTIC ULCER OF THE GREATER CURVATURE OF THE STOMACH\*

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**B**ENIGN ulcers of the greater curvature of the stomach are so extremely rare that lesions, especially niches, found in this location are usually considered to be malignant until proved otherwise. A review of the literature, both early and recent, testifies to the rarity of such occurrence. It also reveals that the real incidence of ulcers of the greater curvature is unknown because most of the reported cases were not proved histologically nor followed up adequately.

Finsterer and Glaessner<sup>5</sup> apparently were the first to call specific attention to this important subject with their review of all the cases up to 1914. They found 36 reported as ulcer on the greater curvature. Blaine,<sup>1</sup> in 1925, contributed 3 additional cases. David<sup>4</sup> reviewed all the cases from 1914 to 1928. These included 2 additional cases of Sutherland<sup>15</sup> in 1925, and excluded those reported by Blaine. He found 24 reported as ulcers of the greater curvature. Sproull,<sup>14</sup> however, in an excellent critical analysis of these foregoing authors' cases and others up to 1931, stated that according to his understanding of peptic ulcer only 10 of all these cases proved to be ulcers of the greater curvature, both by histologic examination and by location. He then cited one case of his own to caution against the danger of such unproved diagnoses. This was a woman, aged twenty-four, with a peptic ulcer syndrome of one year duration. Roentgenograms revealed a definite lesion on the greater curvature. At operation, the surgeon thought it was benign, and it was locally excised. Microscopically it proved to be carcinomatous and the patient died two years later of a large, inoperable carcinoma.

Significantly, Sproull concluded from his own experience and that of the leading roentgenologists of his time, that it was unwise for a roentgenologist to diagnose a lesion on the greater curvature as benign. The chance of the diagnosis being correct, he stated, was one in a million. Obviously, he counselled against the medical treatment of any lesion on the greater curvature.

In the following years, Holmes and Hampton<sup>8</sup> in 1932 studied 202 autopsy cases and did not find a single instance of an ulcer of the greater curvature. They also quoted Orator who studied 330 cases of gastric ulcers from Eiselberg's clinic, both grossly and histologically, and found no benign ulcers of the greater curvature.

In 1933, Bowers and Rivers<sup>3</sup> reviewed the records of 617 benign cases of gastric ulcer in which exploration had been done and found none on the greater curvature. In another series of 240 cases, 120 benign ulcers and 120 malignant lesions, they found 4 on the greater curvature. All of these were malignant. Interestingly, they concluded that the closer an ulcer came to the pylorus or greater curvature, the more likely it was to be malignant.

Matthews,<sup>13</sup> in a painstaking critique, brought the literature up to 1935. He concluded that only 22 cases were reported in sufficient detail to warrant a diagnosis of true greater curvature ulcer. Of these, however, further study revealed that only 10 were proved histologically. He contributed 2 additional cases of his own, both on the greater curvature, one 12 cm. and the other 14 cm. from the pylorus. Both of these were proved microscopically, and both were well on follow up, one after five and a half years

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FIG. 1. Immediate roentgenogram (January 11, 1943), showing a large, irregular, polypoid-like filling defect in the antral region involving the greater curvature. Note the niche and also the accentuated and convergent rugae.

and the other after fifteen months. This latter case had perforated through the gastrocolic omentum.

In the recent literature van Buchem<sup>16</sup> added a single case in 1938, of a large crater on the greater curvature confirmed at operation and histologically benign. The patient was well after a three year follow up. Williams,<sup>17</sup> in a concise but nevertheless pointed paper in December, 1941, presented 2 more cases, both seen at autopsy and histologically confirmed. This brought the total of proved cases of ulcer of the greater curvature in the entire literature to fifteen. His first case had a 1.5 cm. ulcer about 0.5 cm. from the pylorus on the greater curvature of the prepylorus. It had caused a marked degree of pylorospasm producing a large six hour residue. A diagnosis of carcinoma had been made. The second case revealed a large ulcer, 4 cm. in

diameter, 6 cm. from the pylorus with smooth undermined edges, astride the greater curvature, which had extended posteriorly to the pancreas.

At the Bronx Facility of the United States Veterans Administration, the case herewith reported was recently treated. Even though exact statistics are not available, it was the first case of benign ulcer of the greater curvature encountered among several thousand peptic ulcers diagnosed roentgenologically and among several hundred which came to surgery. Because of its rarity and because of several interesting and intriguing features in its diagnosis, the case is reported in some detail.

#### REPORT OF CASE

P. P. J. (No. 51649), white male, aged forty-nine, was admitted on December 30, 1942, with a history of having had "stomach trouble and indigestion" for the past ten to twelve years. This consisted of epigastric pain and discomfort a few hours after meals. At times he would



FIG. 2. Right oblique position (January 11, 1943), revealing the area of defect along the greater curvature with prominence of the large ulcer niche.

vomit when this occurred. He was often awakened at night by this pain, which was local and did not radiate. He had been treated at various times for an ulcer of the stomach, under which treatment he went along fairly well, until August, 1942. At that time he had a severe gastric hemorrhage which necessitated three blood transfusions at a private hospital. After recuperating from this, he was hospitalized at the United States Veterans Facility at Togus, Maine, from December 3 to 29, 1942, where, after a complete examination he was referred to our hospital with a diagnosis of carcinoma of the stomach. He had lost about 40 pounds in the past five months, but in the last three to four weeks he claimed he had gained back 15 pounds and felt generally stronger. However, his appetite was still poor. His bowels were regular and stools were not tarry.

*Physical Examination.* This revealed a white male who looked chronically ill and somewhat anemic in appearance. The sclerae and mucous membranes were pale in color. The general examination was essentially devoid of positive findings. There were no palpable nodes in the neck. The liver and spleen were not palpable nor were there any other abdominal masses



FIG. 4. Five hours after ingestion of barium meal (December 29, 1942). The defect along the greater curvature is still visible and the ulcer crater is delineated very plainly by the barium.

present. Rectal digital examination revealed no shelf and the prostate was within normal limits. The patient weighed 137 pounds and his temperature, pulse and respiration were normal.

*Laboratory Data.* On December 30, 1942, the blood count revealed a secondary anemia. The hemoglobin was 52.9 per cent, erythrocytes 2,990,000, leukocytes 9,000, with a differential count of 66 per cent polymorphonuclears, 30 per cent lymphocytes, 2 per cent monocytes and 2 per cent eosinophiles. On January 16, 1943, the hemoglobin was 51.4 per cent, the erythrocyte count was 3,400,000 and the leukocyte count 6,700. Several urine specimens were within normal limits. Several specimens of stool were positive for occult blood and negative for ova and parasites. The blood Wassermann and Kahn tests were negative. Gastric analysis one hour after an Ewald test meal showed a free HCl of 57 units, a total acidity of 70, acid salts of 6, no organic acids and no Boas-Oppler bacilli present. Report of the gastric analysis done at the previous hospital one month earlier revealed a free HCl of 35 units, a total acidity of 55, combined 11, no lactic acid and was positive for occult blood.

*Roentgen Examination.* A gastrointestinal series done on January 11, 1943, revealed the

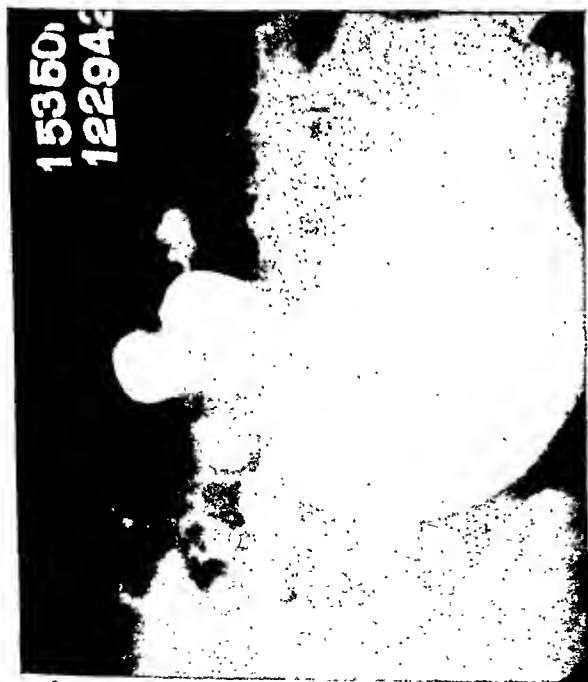


FIG. 3. Immediate roentgenogram (December 29, 1942) from previous hospitalization. The stomach is more dilated. The accentuated rugae clearly converge toward the ulcer niche on the greater curvature.



FIG. 5. Photomicrograph ( $\times 120$ ) of the margin of the ulcer. There is no evidence of malignant change. Note transition from glandular mucosa to erosion of the ulcer.

following: The esophagus was normal; the stomach was slightly dilated. The greater curvature in its distal half was irregular. This was chiefly due to a large polypoid-like defect in the antral region, 5 cm. in diameter. Below this area of defect was a niche on the greater curvature, measuring 2.5 cm. in diameter, which probably represented an ulcer crater (Fig. 1 and 2). The rugae surrounding this area were prominent and seemed to converge toward it. On roentgenoscopy they could not be effaced. Peristaltic waves did not pass over this area. A definite meniscus sign could not be demonstrated. At six hours, there was a small gastric residue which still outlined the crater, and the remainder of the meal lay in the terminal ileum. At twenty-four hours, the barium was in the colon which was fairly well filled and appeared normal.

In connection with the roentgen findings, it is interesting to note the roentgenograms taken at the previous hospital two weeks earlier (December 29, 1942) because they bring out more clearly the large ulcer niche on the greater curvature (Fig. 3 and 4). Unfortunately, we did not have these roentgenograms at the time of operation. In addition to the gastric findings, both sets of roentgenograms also showed a chronic duodenal ulcer as evidenced by deformity of the duodenum and definite gastric retention.

*Operative Findings.* Principally because of the location and size of the lesion, a diagnosis of carcinoma of the greater curvature was made and the patient was prepared for surgery with transfusions, and so forth. On January 21, 1943, under spinal anesthesia, an exploratory operation was done. Essentially the main findings were as follows: A large ulcer 5 cm. in diameter was found astride the greater curvature with one leg, so to speak, extending somewhat on to the posterior wall. In its center was a large crater, which could be felt by invaginating the stomach wall with the finger. The margins of the ulcer were hard and indurated but regular. The transverse colon and gastrocolic ligament were drawn up beneath the posterior wall of the stomach as a result of some sort of a fibrotic, indurated process. The liver and other viscera were explored and showed no evidence of metastases. One small node was felt on the lesser curvature. Since the surgeons could not tell by gross inspection alone whether the ulcer was benign or malignant, an incision was made in the anterior wall of the stomach to ascertain this by biopsy and frozen section, and also to see more clearly the extent of the ulcer. It was then seen that the rugae surrounding the ulcer were hypertrophied and edematous and stood out rather stiffly, and converged toward the ulcer. The mucosa was definitely thickened. The first portion of the duodenum revealed



FIG. 6. Photomicrograph ( $\times 110$ ) of the base of the ulcer. There is no evidence of malignancy; only a chronic inflammatory process is present down to the muscularis.

scarring and dense adhesions, evidence of a former duodenal lesion, probably ulcer.

Since the frozen sections were reported suspicious for malignancy and because of the posterior extension, it was deemed wise to do a subtotal gastric resection. Approximately two-thirds of the stomach was removed and the gastrojejunostomy attached ante-colically. In addition, an obstructive resection of the mid-portion of the transverse colon and attached greater omentum was done. The remaining colon was colostomized and on March 15, 1943, following preliminary crushing of the spur, the colostomy was suppressed.

*Pathologic Findings.* The removed portion of the stomach measured 14 cm. in length. At the distal end, 6 cm. from the pylorus, and on the greater curvature was an oval defect 5 cm. in diameter with its posterior portion extending slightly on to the posterior wall. The mucosa about the ulcer was hypertrophied and the rugae edematous. The bottom or the crater of the ulcer was involved in an indurated fibrotic process which evidently had penetrated or perforated through the stomach at one time, and involved the gastrocolic ligament and the serosal surface of the transverse colon at the mid-point of the resected specimen, which itself measured 12 cm. in length. The small lymph node was not grossly characteristic of any pathologic condition.

*Histopathology.* Several sections through various sites of the ulcer (margins, sides and base) revealed no evidence of malignant change (Fig. 5 and 6). The mucosa, submucosa, and muscularis were infiltrated by numerous lymphocytes and plasma cells, evidence of chronic inflammatory changes. Sections through the transverse colon showed no malignant changes. The chronic inflammatory process had invaded the serosa and muscularis and many eosinophiles were also seen. The lymph node showed only chronic inflammatory lymphoid hyperplasia (Fig. 7).

The diagnosis, pathologically, was penetrating peptic ulcer. These conclusions were verified by Dr. Fred Stewart of Memorial Hospital, our consulting pathologist.

*Subsequent Course.* Following the resections and suppression of the colostomy, the patient made an uneventful recovery and was discharged on April 6, 1943. He had no complaints referable to the gastrointestinal tract and regained 15 pounds lost during the hospital stay. When last heard from, six months after dis-

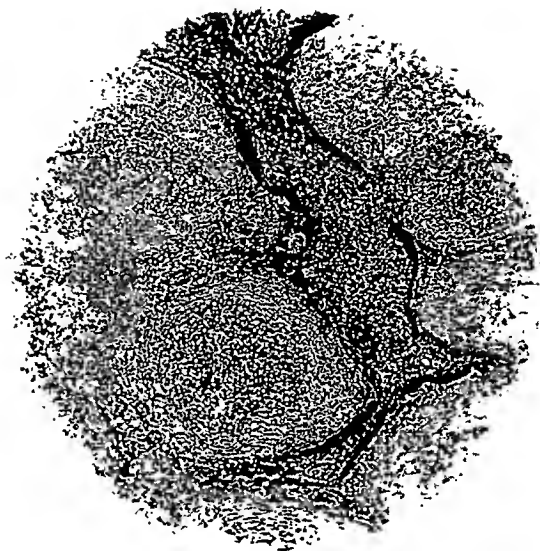


FIG. 7. Photomicrograph ( $\times 110$ ) of small node found on the lesser curvature. No malignancy is present.

charge, the patient was feeling well, had not lost any weight and had had no gastric symptoms.

#### DISCUSSION

In the case reported there were several interesting features in the differential diagnosis which confronted us, and which merit review. Were we dealing with a large benign ulcer or was it a malignant tumor which, mainly because of its size and location, demanded immediate surgical intervention, rather than a period of medical treatment? To answer this satisfactorily, the many features which are of value in an attempt to establish a differential diagnosis between benign and malignant gastric ulcer had to be considered.

As Eusterman<sup>7</sup> has pointed out, among those that favor benignancy are long duration of symptoms (ten years or more), age of patient (thirty years or less), free hydrochloric acid in the stomach contents (40 units or more), local tenderness on roentgenologic examination, and an hour-glass type of deformity of the stomach. Those symptoms and signs that favor malignancy are late onset in an elderly patient, an irregular syndrome, achlorhydria associated with obstruction, the meniscus sign-com-

plex and the visualization of a large and irregular niche on roentgenologic examination, and the location of the ulcer in the prepyloric area, on the greater curvature, or on the posterior wall of the stomach. Thus, in the case reported, criteria of both benignancy and malignancy were present. Favoring benignancy were the history of long duration of peptic symptoms (ten to twelve years), the episode of severe gastric hemorrhage with recovery, free hydrochloric acid in the stomach contents of 57 and 35 units on two occasions, together with a high total acidity, and the accentuation and convergence of the adjacent gastric rugae toward the ulcer on roentgenologic appearance and the absence of a definite meniscus sign-complex. In favor of malignancy were the age of the patient, forty-nine years, a poor appetite, a definite secondary anemia, loss of 40 pounds in weight in five months, some gastric retention and a large niche located on the greater curvature.

The weight of evidence pointed heavily toward malignancy; yet, considering all the criteria, as Eusterman has emphasized, great caution is necessary in any decision concerning malignancy, because malignant gastric ulcer may successfully mimic a benign lesion. Sara Jordan,<sup>2</sup> however, and others have repeatedly stated that "neither the size of the ulcer nor the age of the patient, nor the presence of normal acid or hyperchlorhydria should lessen our suspicion of carcinoma."

In view of the foregoing, the differential diagnosis narrowed itself down to a consideration of two principal features, the size and location of the ulcer. The size of the entire ulcer was large, measuring 5 cm. in diameter, and the size of the ulcer crater itself slightly over 2.5 cm. in diameter. It is generally known that the larger the ulcer, the greater the chance of malignancy. MacCarty<sup>12</sup> in the Carman lecture of 1940, supports this by stating that at least 90 per cent of all chronic gastric ulcers larger than a quarter (2.5 cm.) are definitely cancers.

Kirklin,<sup>9</sup> on the other hand, using the

size of the ulcer niche as a diagnostic sign in differentiating between benign and malignant ulcer, has said that in every case when the ulcer niche measures over 2.5 cm. in diameter, a malignant process should be suspected. The size of the ulcer and ulcer niche in this case, therefore, both added some real certainty to the conclusion that the nature of the lesion present was malignant.

Finally, considering the location of the ulcer brings us to a discussion of the last of the important criteria and the "raison d'être" of this paper. As has already been stated, one of the most generally accepted diagnostic criteria in differentiating between benign and malignant gastric ulcers is based upon location of the niche. It is almost a truism, if one is to believe the literature and the best medical opinion, that a niche found on the greater curvature of any part of the stomach is generally considered malignant. Only recently in 1943, Lahey,<sup>2</sup> in discussing a paper by Boles<sup>2</sup> on peptic ulcer, stated, "We agree that we have never seen a benign ulcerating lesion on the greater curvature."

In support of this great surgeon's opinion is that of a leading contemporary radiologist, Kirklin,<sup>10</sup> who in a personal communication, says, "I have made the statement, however, for all practical purposes, that ulcers truly on the greater curvature are malignant, realizing of course that there are rare exceptions to this rule." In support of these statements, statistics from the Mayo Clinic<sup>2</sup> reveal that malignancy was found in 10 per cent of lesser curvature ulcers, while 65 per cent of the prepyloric and all of the greater curvature ulcers were malignant.

Thus, all diagnostic criteria carefully considered, especially that of location on the greater curvature, the lesion in the case reported was thought to be malignant. Even at surgical exploration two surgeons could not tell definitely whether the lesion was grossly benign or malignant. Since even frozen sections were thought to be suspicious of malignancy, a partial gastric resec-



tion was carried out. Fortunately for the patient and somewhat to our surprise, the histopathological report was benign penetrating ulcer. The surgical treatment, it is felt, was the proper procedure in view of the fact that complications may arise even when a large ulcer is benign. In fact, one of these had already occurred in the form of a penetration and extension to the gastrocolic omentum and transverse colon, which necessitated an accompanying resection of these involved parts.

## SUMMARY

The literature is reviewed and from this benign ulcers of the greater curvature of the stomach are found to be extremely rare. Their real incidence is unknown mainly because of lack of histological proof and inadequate follow up of the cases reported. Only 15 proved cases have been found in the literature. To this is added another case of a large gastric ulcer on the greater curvature demonstrated roentgenographically and proved by surgical resection and histopathological confirmation. The patient is alive and well, without symptoms of peptic ulcer, six months post-operatively. It is almost a truism, according to the literature and the best medical opinion of the day, that a niche located on any part of the greater curvature of the stomach should be considered malignant until proved otherwise.

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# THE ROENTGEN APPEARANCE OF COMMON DUCT STONE\*

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THIS report is presented to emphasize the fact that a diagnosis of common duct stone can be made by careful study of a flat roentgenogram of the abdomen or a spot roentgenogram of the bile duct area. Our conclusions are based on roentgenologic examinations in 12 proved cases of common duct stone, with special reference given to opaque stones. The demonstration of a common duct stone on a plain roentgenogram is of value to the patient and to the surgeon. If the patient is very ill it may spare him more extensive examinations. It may guide the surgeon to the site of the stone, or stones, and permit a preoperative estimate of the size of the common duct. If necessary, cholecystography, intravenous pyelography, or a gastrointestinal series may be resorted to at a later time for more definite localization of the area of calcification.

The fact that common duct stones can be seen on the plain roentgenogram is not generally appreciated. In a brief review of the literature only one American reference to this possibility was found.† Walters and Snell, writing in 1940 on diseases of the biliary tract, do not mention this method of diagnosing common duct stone despite the fact that clinical and roentgenologic diagnosis is discussed in considerable detail. The value of the plain roentgenogram is not mentioned by Judd, Lahey, Allen, or others, writing in the past five years on the common duct stone, cholangiography and cholecystography. This omission is probably due to two factors: (1) the relative infrequency of common duct stones, and (2) the difficulty in demonstrating their location accurately.

Diagnosis of common duct stone from the plain roentgenogram is dependent upon the presence of calcification of sufficient concentration to give a positive shadow (Fig. 1). The roentgenogram should be of the best quality and preferably either stereoscopic or posteroanterior and lateral. (Even a poor quality roentgenogram will demonstrate the stone if it is very dense.) Because the common duct lies near the center of the body in the anteroposterior plane, visualization of stones in this area is more difficult than is the demonstration of gallbladder stones (Fig. 2). Gallstones, due to their proximity to the anterior abdominal wall, show more distinctly and with less distortion (Fig. 3). The rotating anode tube with its small focal spots has increased definition so that in the future common duct stones will probably be seen

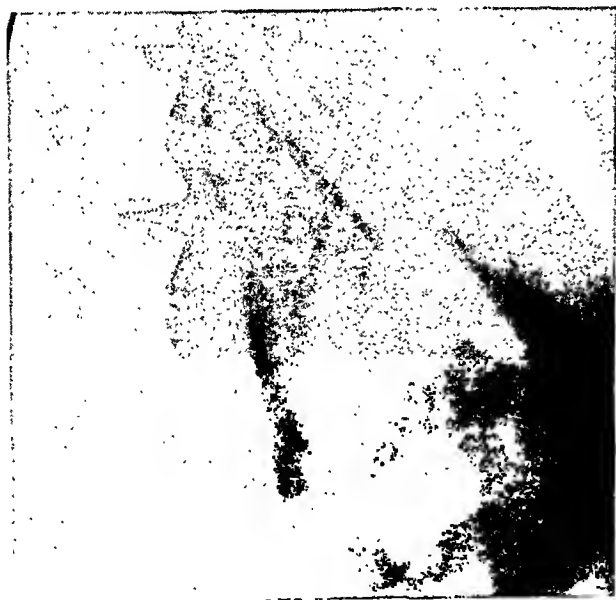


FIG. 1. Plain roentgenogram showing two common duct stones. These were diagnosed roentgenologically and were confirmed at operation.

† George, A. W., and Leonard, R. D. The Pathological Gall Bladder. *Ann. Roentgenol.* Vol. II, 1922. Paul B. Hoeber, New York.

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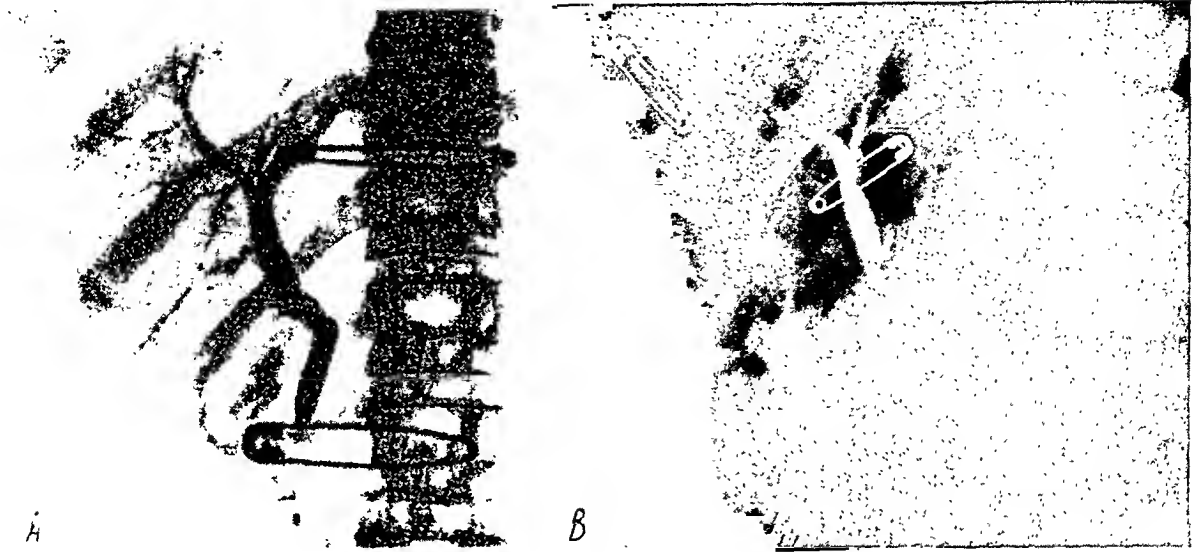


FIG. 2. Normal postoperative cholangiogram. *A*, note the relatively short common duct and the fact that it lies below the ribs; also that it crosses the upper medial pole of the right kidney and the lower end lies in the region of the renal pelvis. *B*, lateral view demonstrating the location of the common duct in the middle of the body anterior to the spine except for the extreme distal end.

with greater frequency. At the Massachusetts General Hospital we see about two cases of easily demonstrable common duct stone per year at the present time, whereas formerly this diagnosis was rare.

The chief difficulty in diagnosing common duct stones without a contrast substance lies in establishing their correct

location. The differentiation of common duct stone from renal or cystic stone, therefore, is the first problem to be solved. Figure 4 illustrates the possible confusion between renal and common duct stone. The patient, prior to her admission to this hospital, had had a negative exploration performed because of an incorrect roent-



FIG. 3. *A*, a gallbladder full of stones and a stone in the common duct which was not diagnosed. *B*, post-operative roentgenogram shows stone remaining in the common duct. The patient had to be operated on again.

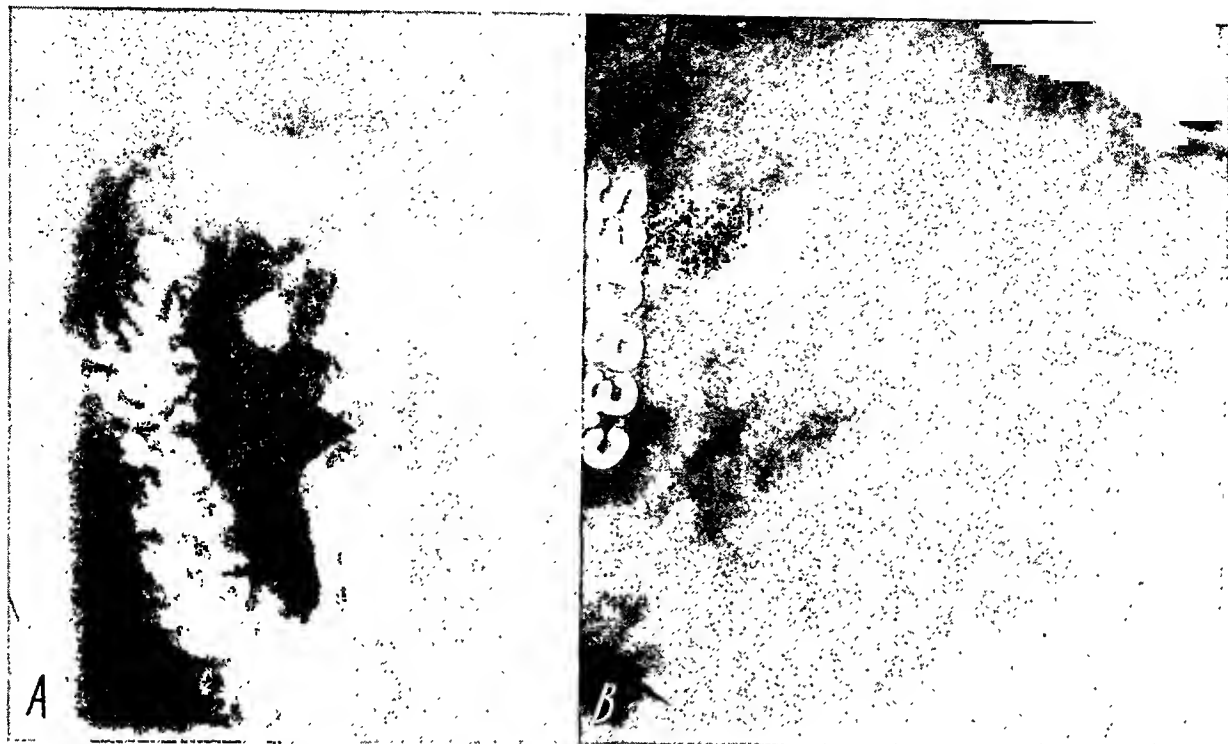


FIG. 4. *A*, the stone seems to lie in the region of the renal pelvis. A mistaken diagnosis of kidney stone was made and a negative exploratory operation had been performed. *B*, lateral view reveals that the stone is well anterior to the kidney.

genologic diagnosis of renal stone. The difficulty in this differentiation arises from the fact that in the posteroanterior and anteroposterior roentgenogram the common duct overlies the upper pole of the kidney, while the lower end of the duct usually overlies the renal pelvis. A common

duct stone, however, can be well visualized on a true lateral view (Fig. 4). In this view the stone will be found to lie anterior to the spine, whereas a renal or ureteral stone will overlie the spine unless there is marked displacement of the kidney by tumor. Only if the stone lies in the ampulla will it be seen far enough posteriorly to simulate a renal stone. In obscure cases, intravenous or retrograde pyelography may be required to distinguish between these two types of calculi (Fig. 5). This procedure will eliminate the possibility of the stone being in the kidney if it is seen to lie outside the renal calices and pelvis.

The decision as to whether a calculus lies in the common duct or in the cystic duct is occasionally a difficult one to make. Since a stone in the cystic duct may lead to hydrops of the gallbladder, while one in the common duct would not do so, the finding of a mass in the gallbladder region associated with calculus is indicative of a cystic duct stone (Fig. 6). The converse is not always true, however; the cystic duct stone may not necessarily cause hydrops

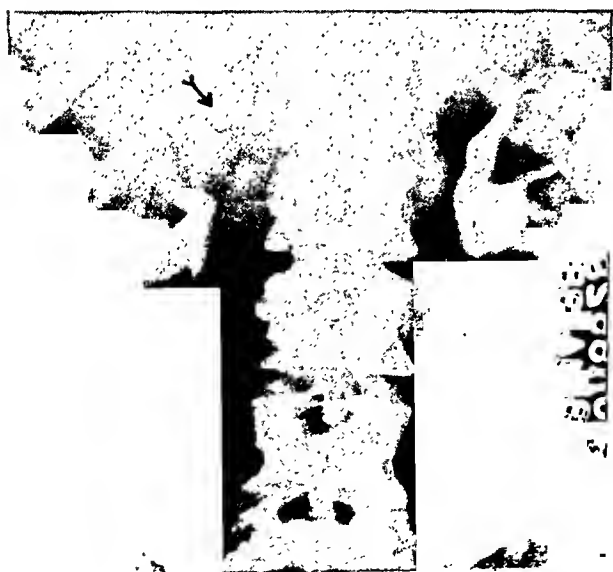


FIG. 5. Intravenous pyelogram shows the location of the stone to be outside the kidney pelvis.

of the gallbladder. In some instances, examination with barium by mouth may be necessary to determine the exact location. If, in the anteroposterior projection, the stone is seen to lie in the region of the duodenum, or in the duodenal loop, the conclusion that it is in the common duct is justifiable, since it will be below the junction of the cystic and common ducts (Fig. 7). This method of examination will also



FIG. 6. A cystic duct stone with hydrops of the gallbladder. Arrows indicate the outline of the enlarged gallbladder.

demonstrate the relationship of the stone to the ampulla.

In a rare case, when the Graham test has been made in addition to the flat roentgenogram, a diseased gallbladder may be found which retains its power of concentrating dye and subsequently contracting after a fatty meal (Fig. 8). In such an instance, however, the bile ducts would probably be outlined by dye and a stone could still be accurately located. Only in a very few cases will exact localization of a stone be impossible.



FIG. 7. A common duct stone located by barium in the duodenum.

Calcium bile milk is a frequent concomitant of common duct stone (Fig. 9). In the majority of cases this roentgenologic finding will give confirmatory evidence of the diagnosis. Clinical corroboration is found in the presence of jaundice in the patient.

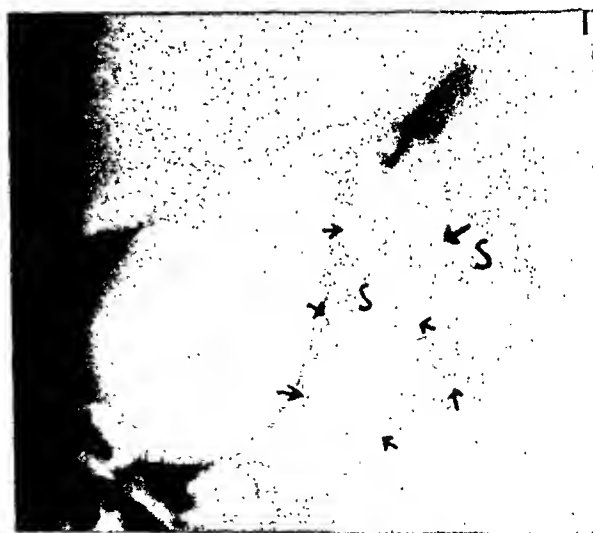


FIG. 8. Cholecystogram. The dye is in the gallbladder and common duct, outlining the common duct and showing definitely that the stone lies within it.



FIG. 9. Calcium bile milk in the gallbladder with a stone in the region of the common duct.

While common duct stones can, and often do, occur without jaundice being present, in many instances they lead to this clinical sign. In our experience, 4 out of 7 cases of roentgenologically and surgically proved common duct stones showed jaundice.

The differentiation of common duct stones from other areas of calcification seen on a plain roentgenogram is not as a rule difficult. Calcification of costal cartilage may be present, but it is usually above, and always anterior to, the common duct. The mistaking of an echinococcus cyst for

a common duct stone is conceivable but unlikely. The patient's history and the roentgenologic appearance of the calculus usually establishes one or the other diagnosis. In the presence of an echinococcus cyst, a rounded area of calcification, generally larger than a common duct stone and lying above the common duct, is seen, with fine comma-shaped areas of calcium in the periphery.

Calcified abdominal vessels may cast a confusing cylindrical shadow, but such a shadow will be seen to change its shape with a change in the direction of the roentgen-ray beam. Absence of signs of extensive arteriosclerosis elsewhere in the patient should also rule against a diagnosis of calcification of vascular origin.

#### SUMMARY AND CONCLUSIONS

1. Common duct stones can often be demonstrated on plain abdominal roentgenograms or spot roentgenograms of the bile duct area. They should be suspected in any case (*a*) in which calcification is seen in the region of the gallbladder or common duct, (*b*) in which calcium bile milk is demonstrated, or (*c*) in which the patient is jaundiced.

2. In order to localize calculi accurately intravenous pyelography, cholecystography, and barium study of the upper gastrointestinal tract may be required in addition to the plain roentgenogram.

3. Certain characteristics differentiating common ducts stones are described.



# PULMONARY CHANGES IN CHRONIC CYSTIC PANCREATIC DISEASE

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THE changing concepts of disease entities attest to the dominant kinetic forces that motivate the entire field of medicine, and the roentgenologist is so oriented that he is obliged to maintain a flexibility that permits him to respond adequately to these forces. Thus, though we are all familiar with the roentgen diagnosis of bronchopneumonia and bronchiectasis in the infant, we must in the light of recent work on pancreatic disease of children modify our ways of thinking when confronted with infant chest roentgenograms.

Andersen,<sup>12</sup> Blackfan and May<sup>4</sup> and others, have established chronic cystic fibrosis of the pancreas as a definite disease entity. In a thorough and admirable study of clinical and pathological material, Andersen described certain striking changes seen in a number of infants who succumbed to pulmonary infections. She found that the pancreas was small and irregular and that microscopically it was composed of small and large cysts lined with epithelium. The ducts were usually embedded in masses of fibrous tissue. The lungs in all cases showed bronchitis and bronchopneumonia along with many instances of bronchiectasis and atelectasis.

Clinically, the cases can arbitrarily be placed in three groups:

1. Cases of infants who succumb within the first two weeks of life. About 10 per cent of all known cases fall into this group.
2. Infants dying from bronchopneumonia or other pulmonary lesions before the age of six months. This group constitutes the largest percentage of known cases.
3. A small group who survived from six months to fourteen years and who clinically presented the so-called celiac syndrome.

Interest centers chiefly about those in the second group, for it is here that the diagnosis is most difficult and confusing. The usual history is one of a child who has frequent colds and who fails to gain weight. The child has diarrhea and foul stools at times, but with the pulmonary picture so predominant all attention is focused on the respiratory tract, so that the underlying disease process is very apt to go unrecognized.

The disease entity stands established but the relationship between the pancreatic and pulmonary lesions is as yet somewhat obscure. Andersen is of the opinion that the pancreatic changes follow obstruction of the ducts and that once the alterations in this gland are manifest, a resultant deficiency in fat absorption and metabolism ensues. This, in turn, leads to a vitamin A deficiency which results in serious epithelial changes. Rauch, Litvak and Steiner<sup>6</sup> do not adhere to this conception and believe that the changes are based on a coexisting congenital abnormality of the pancreas and lungs.

Even though experimental studies have failed to establish any definite relationship between vitamin A deficiencies and pulmonary epithelial lesions, the clinical and pathological evidences of a close relationship is so impressive that we cannot dismiss this hypothesis.

The disease is considered rare, but it has been aptly pointed out that it is the diagnosis rather than the condition that is rare. Undoubtedly the entity will be recognized more frequently in the future due to the able work of those who have made the basic contributions. There are no short cuts to a correct diagnosis and each case must be studied thoroughly. A low vitamin A absorption curve is a constant finding; steatorrhea is also present in all cases.

However, these changes are not diagnostic for they are known to occur in other conditions. The most reliable clinical procedure is an assay of the pancreatic enzymes, for the absence of pancreatic trypsin and lipase in the duodenal contents is absolute evidence of a pancreatic deficiency.

The prognosis is poor and thus far most of our information stems from autopsy material. This fact, however, does not justify a negative approach to this problem, for it is

conforms to a definite pattern and is most marked wherever there is a greater abundance of epithelium. By virtue of the distribution of the pulmonary epithelium, the infection that becomes manifest must necessarily involve all the lobes more or less equally. Acquainted with these facts, we can now anticipate the roentgen picture. The hilar regions show marked involvement characterized by areas of increased mottled densities. Towards the periphery there is

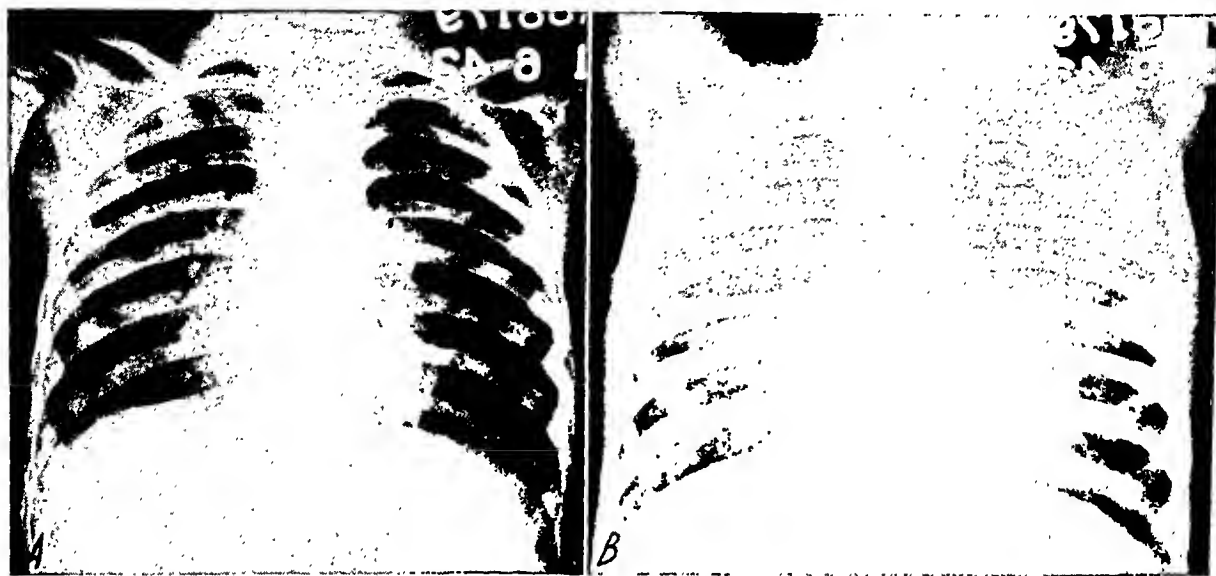


FIG. 1, *A* and *B*. Roentgenograms of the chest showing the typical distribution of the lesions and the progress of the disease over a six month period.

only when the disease process is understood and recognized early that any progress can be made therapeutically. There are some instances on record in which intensive supportive and vitamin therapy have resulted in at least temporary clinical improvement.

What rôle does the roentgenologist play in this pattern? Once the pathologic physiology of pancreatic disease is understood, we can approach the problem more intelligently and develop a critical attitude concerning bronchopneumonia in the infant. Remembering that the vitamin A deficiency leads to epithelial damage which makes the lungs readily susceptible to infection, we should expect a pulmonary process that

streaking and mottling which is much less pronounced. The roentgen studies of the lungs in all known cases have revealed this picture consistently.

Since the lung alterations are set in force by an underlying pancreatic deficiency, so long as the latter exists we should expect little improvement in the lungs. All evidence bears this out and in the cases followed with roentgenograms there has been a progressive intensification of the visible lesions (Fig. 1, *A* and *B*).

Atelectasis may be expected to occur in a certain percentage of cases, for once the epithelium is damaged and infection is present, purulent exudates are apt to form and lead to bronchial obstruction. Attwood

and Sargent<sup>3</sup> in their presentation of 4 cases demonstrated atelectasis in the roentgenograms and also at autopsy.

Another concomitant of the serious epithelial change and infection is, of course, bronchiectasis. Andersen found that a high percentage of children with pancreatic disease did have bronchiectasis at autopsy. Attwood and Sargent<sup>3</sup> made the same observation. As is well known, there is but one way to establish definitely the diagnosis of bronchiectasis, and this necessitates the use of opaque medium instilled into the bronchial tree. Nevertheless, there are certain features in a chest roentgenogram which often lead one to suspect bronchiectasis. Persistent mottling at the bases, a honeycomb-like picture in the lower lung fields coupled with linear streaks that follow the bronchial pattern should put us on the alert. These features have been seen in cases of pancreatic disease and when present justify further investigation with bronchograms. Andersen has stated that any infant having bronchiectasis must be studied as a possible case of pancreatic disease (Fig. 2).

The roentgenograms recorded in several articles and those in a few cases which we are following at the present time all show a most striking similarity. The changes are those just described and they seem pertinent, though they are not diagnostic. It can be argued that similar pictures are seen in infants who have no underlying pancreatic deficiency, and such arguments are difficult to refute. Yet, unless the roentgenologist develops an understanding of this important pediatric problem, he will never appreciate the possible significance of the chest roentgenogram that is characterized by symmetrical mottling of all lobes of the lungs. The roentgen picture is so consistent that even though it cannot be considered absolutely diagnostic, when present it should certainly arouse suspicions of the possibility of fibrocystic pancreatitis. Without an awareness of the condition the roentgenologist cannot hope to stimulate the

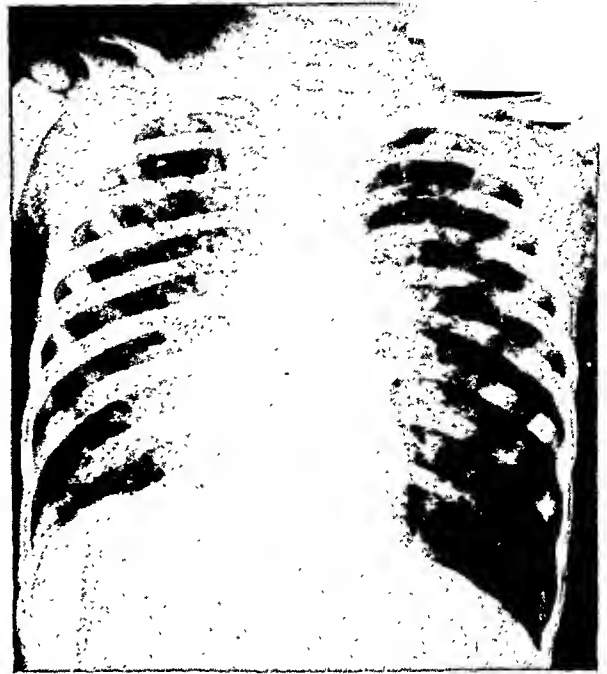


FIG. 2. Roentgenogram showing the same typical distribution of the lesions with the predominant changes in the inner third of the lungs.

clinician. On the other hand, having developed that awareness he may well be instrumental in instituting further clinical search that will in some instances discover an otherwise unsuspected disease.

Another roentgen aspect of cystic fibrosis of the pancreas concerns the secondary changes in the intestinal tract physiology. Flax and his coworkers<sup>5</sup> have demonstrated hypomotility associated with some dilatation of the small intestine. Occasionally these changes are manifest even without barium studies, for the plain roentgenograms may show fluid levels in segments of the small intestine. These findings are in no way pathognomonic, but when seen in conjunction with the described pulmonary picture, they are of such significance as to make further clinical studies mandatory.

I do not wish to convey the opinion that the roentgenologist can arrive at the diagnosis of chronic cystic pancreatitis without equivocation. I do, however, believe that if he is acquainted with this disease entity he will frequently be of distinct aid to the clinician. If the proper diagnosis can be



made early enough vigorous therapeutic measures may lead to clinical improvement.

It is fair to state that the pediatrician has acquainted himself with this problem and that frequently he will be the one who first suspects the diagnosis. Frankly, this has been true in the small number of cases studied thus far at the Duke Hospital. This very fact being true is all the more reason that the roentgenologist be conscious of the problem, lest he be found wanting in his capacity as a consultant.

In conclusion, any infant who shows the lung changes discussed and who fails to improve under the usual modes of therapy should be suspected of having chronic cystic pancreatitis and investigated intensively with this in mind. Then, and only then, will it be possible to make any progress in the eventual solution of this intriguing problem.

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# THE ROENTGEN DIAGNOSIS OF PANCREATIC DISEASE\*

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**I**NASMUCH as we have been able to examine roentgenographically a large variety of cases of pancreatic disease, which were studied also pathologically, we find it possible to review critically and to illustrate the criteria for the roentgen interpretation of diseases of the pancreas.

The roentgen study of the pancreas is difficult because the specific density of this viscus is the same as that of its surrounding tissues, so that it cannot be visualized directly. Furthermore, it is one of the few viscera in the abdomen which cannot be outlined by a radiopaque substance. Its duct system has been visualized in occasional cases by reflux during cholangiography and by retrograde filling during duodenoscopy. Engel and Lysholm have inflated the stomach with carbon dioxide, partially visualizing the contiguous anterior border of the pancreas. The pancreas has been also visualized incompletely after the induction of artificial pneumoperitoneum and the retroperitoneal injection of air or oxygen using a modified Carelli technique.

These methods are not easy of application and are not without risk or ill effects. It has therefore been necessary, for ordinary routine purposes, to continue with simple indirect methods which demonstrate chiefly mechanical effects upon the contiguous structures, notably the barium- or gas-filled stomach, duodenum and colon. For translation of the roentgen data into terms of pathologic anatomy, an understanding of the gross anatomy of the area is essential.

## ANATOMY

The pancreas is a long retroperitoneal gland lying rather transversely in the posterior portion of the upper half of the abdomen. The greater part of the organ lies behind the stomach. It is 12 to 15 cm. in

length, and consists of a head, neck, body and tail.

The head is flattened and lies within the duodenal curve to the right of the midline, and is related anteriorly to the mid-transverse colon and posteriorly to the abdominal aorta. Its right and inferior borders are molded on to the side of the duodenum, which lies in a groove of the gland substance—the bile duct being interposed as far down as the middle or lower third of the descending duodenum. The uncinate process of the head is that portion which extends towards the left along the third part of the duodenum and is posterior to the superior mesenteric vessels after passing forward through the pancreatic notch.

The neck is about 2.5 cm. in length and is directed first upward and forward and then upward and to the left to join the body. It is related anterosuperiorly to the pylorus. In front and to its right lies the first part of the duodenum. In the upper border of the neck there is a process of glandular substance, the tuber omentale, which generally projects above the lesser curvature of the stomach.

The body is related anteriorly to the stomach. Posteriorly it is in contact with the left kidney and left suprarenal gland.

There are several pancreatic variations: (1) a separation of a part of the head, known as the uncinate process, which then forms a lesser pancreas; (2) a growth of the pancreas around the duodenum which it may practically encircle (annular pancreas), with or without obstruction; (3) an accessory pancreas in the stomach, duodenal or jejunal wall; (4) pancreatic tissue in a Meckel's diverticulum; and (5) ectopic position of the pancreas, as for example, in a diaphragmatic hernia.

The terminal arrangements of the common bile duct and the main and accessory

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pancreatic ducts show several variations. Mehnen, through autopsy of 449 cases, found that the common bile duct and the main pancreatic duct joined above a common sphincter in 61 per cent of his cases. His second most common finding was for each duct to open separately into the duodenum. The third variation was for the duct of Santorini (accessory pancreatic duct) to be the principal pancreatic excretory passage, opening independently into the duodenum.

According to Giordano and Mann, about two-thirds of their subjects showed union of the common and main pancreatic ducts before entering the duodenum and about one-third had separate openings into the duodenum.

The common ducts showed a variation in its relation to the duodenum. There are three main variations, which are numbered, in their order of frequency, on the illustration (Fig. 1).

#### PATHOLOGIC CHANGES

To better understand the roentgen features, lesions of the pancreas may be divided arbitrarily into four groups:

Group 1. Lesions within the pancreas which are demonstrable on a simple roentgenogram.

Group 2. Lesions which may produce effects on contiguous structures.

Group 3. Lesions which produce their effects on structures not intimately related to the pancreas.

Group 4. Lesions which are too small to provide any roentgen manifestations.

*Group 1.* This consists of lesions which are directly demonstrable within the pancreas. Of these, the most common are calculi, which are most likely caused by inspissation of bile in the pancreatic ducts. They are usually multiple and consist of calcium phosphate, calcium carbonate, cholesterol or organic substances. Very rarely infarcts may calcify. Cysts of the pancreas and fat necrosis may calcify subsequently, becoming indistinguishable roentgenographically from ordinary calculi.

Opaque foreign bodies such as bullets,

shrapnel, knife fragments or chicken bones which have perforated into the duodenum have been reported.

Gas abscess with a demonstrable fluid level has also been described.

Occasionally a pancreatic tumor is so dense that it is directly demonstrable on the simple roentgenogram of the abdomen.

*Group 2.* This comprises the lesions which may produce effects in contiguous structures demonstrable roentgenographically. The most important are tumors, of which carcinoma is the most common. It may be difficult occasionally to determine histopathologically whether one is dealing with a primary or a metastatic lesion of the pancreas (Henke and Lubarsch). As to the location of carcinoma, Ewing states that in a series of 386 cases 158 were diffuse, 156 in the head and 28 in the body. He does not mention any occurring in the tail. However, other authors report an incidence of about 1 per cent in the latter location.

Carcinoma of the pancreas is more common in males, 69 per cent, than in females, 31 per cent. It is a disease primarily of middle age, most frequently occurring between the ages of forty and seventy.

Ewing divides carcinoma of the pancreas into groups: (1) Cylindrical cell adenocarcinoma, arising from the ducts, a type which at times produces a massive tumor, and is most frequent in the head, occasionally containing cysts; and (2) carcinoma simplex, a type which is more diffuse, arises from the parenchyma, has considerable desmoplastic properties, and rarely becomes massive.

Metastatic lesions to the pancreas occur with about the same frequency as primary carcinomas. They may be massive and cause considerable enlargement. Practically any tumor may metastasize to the pancreas, but the most common metastases arise in the gastrointestinal tract.

Cysts often reach sufficient size to be demonstrated roentgenographically. Retention cysts, inflammatory cysts, pseudocysts, cystadenomas and congenital cysts have been described. Their individual incidence varies with different authors. Many



FIG. 1. *A, B, C and D*, normal appearance of the barium-filled duodenal loop in the various forms of habitus: *A*, marked hypersthenic; *B*, moderate hypersthenic; *C*, sthenic; *D*, hyposthenic.

*E*, diagram showing three main positional variations of the common duct, numbered in the order of frequency. *F*, example of the use of the Engel and Lysholm method in the normal. *G*, the same method in cancer of the head and body, showing widening of the retrogastric soft tissues. *H*, visualization of pancreatic duct system by reflux during cholangiography in a case of common duct obstruction near the ampulla, due to non-opaque calculi.

authors state that pseudocysts are most common because of the absence of a true epithelial lining. Others consider, however, that an epithelial lining will be found somewhere in the cyst if numerous sections are made, and that the most common group, therefore, is the cystadenoma (Otani). These may be benign or malignant. They are found most commonly in the body and tail and become extremely large. At times they occupy the entire abdominal cavity and are difficult to differentiate from ovarian or omental cysts.

Inflammatory cysts occur very frequently in the South American countries and are usually due to parasites. Nematodes, taeniae and echinococci have been found in such cysts.

Sarcoma of the pancreas is very uncommon. Those reported were usually lymphosarcoma.

Amyloidosis may occasionally affect the pancreas, causing considerable enlargement.

Annular pancreas is a congenital anomaly, in which the pancreas completely encircles some portion of the duodenum, causing a variable amount of obstruction. There are no definite pathologic findings in the pancreatic tissue, but occasionally one finds considerable atrophy and shrinkage in the portion which surrounds the duodenum.

Aberrant pancreatic tissue has been found distributed over many different portions of the gastrointestinal tract. On occasion it has been reported in the second



FIG. 2. *A*, carcinoma of the pancreatic head  $1\frac{1}{2}$  inches in diameter. *B*, Changes similar to *A*, due to metastatic nodes from a gastric carcinoma. *C*, carcinoma of the pancreatic head  $2\frac{1}{2}$  inches in diameter. *D*, carcinoma of the pancreatic head 4 inches in diameter—note diverticulum of ascending duodenum marked *x*. *E*, extra-renal soft tissue mass in the right upper quadrant seen during pyelography. *F*, same as *E*, which shows mass to be within duodenal loop, and was later found to be carcinoma of the pancreatic head. *G*, intussusception of stomach far into the duodenum, widening it. *H*, same case after the intussusception is reduced. *I*, carcinoma of the head of the pancreas with perforation into the duodenum—perforation pocket is marked *x*. *J*, indentation of the lesser curvature of the stomach due to carcinoma of the pancreatic head, in a very hyposthenic individual. *K*, deformity of the duodenum due to an infiltrating carcinoma of the pancreatic head. *L* and *M*, small localized defect due to carcinoma of the ampulla. *N*, pressure defect on the

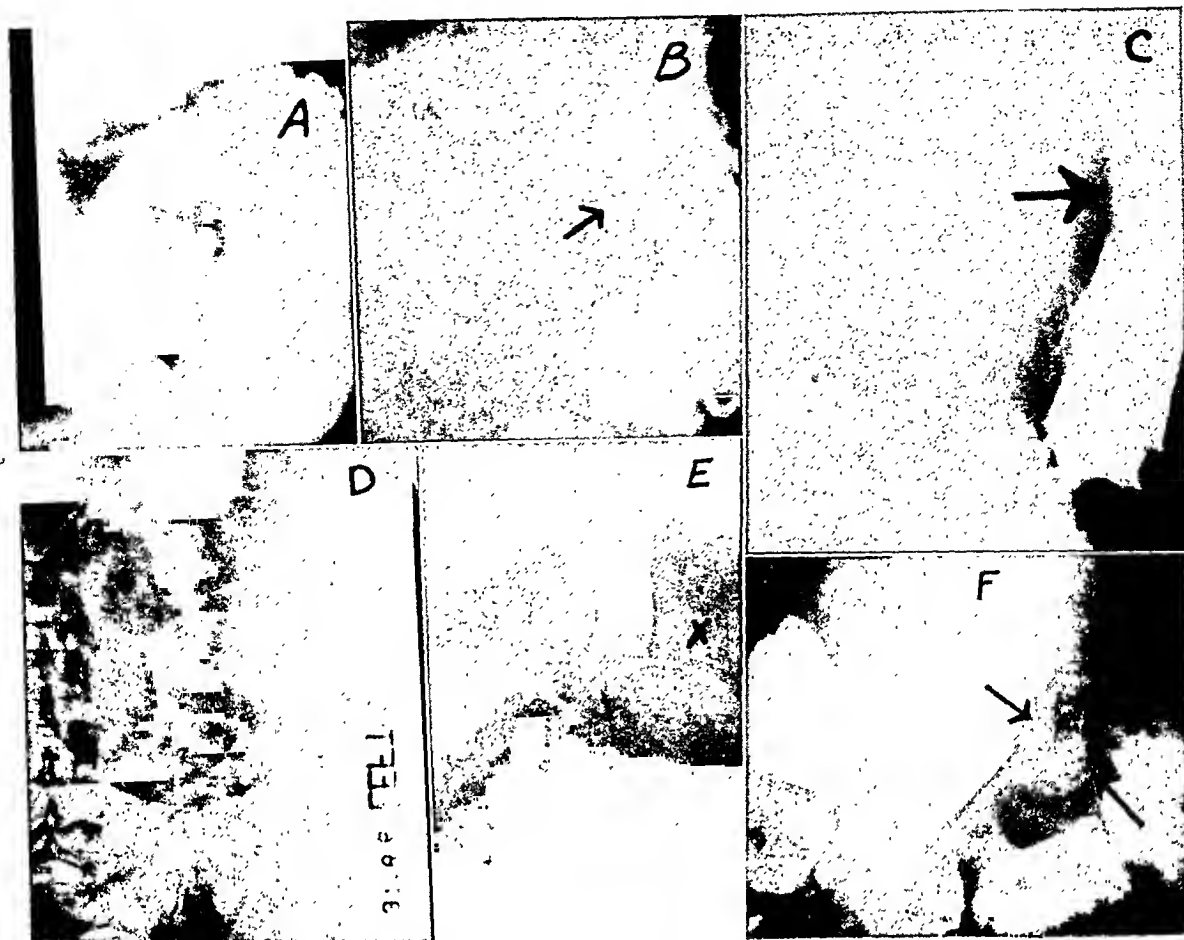


FIG. 3. *A*, carcinoma of the pancreatic tail. *B*, benign cyst in the pancreatic tail, measuring  $2\frac{1}{2}$  inches in diameter. *C*, carcinoma of the body and tail, causing a forward displacement of the stomach which has previously been partially resected; a few pancreatic calculi are seen. *D*, large calcified pancreatic cyst arising in the tail. *E*, same as *D*, showing marked indentation of the stomach—marked *x*. *F*, small irregular calcifications in a pancreatic cyst of the tail after marsupialization.

portion of the duodenum, causing a filling defect.

Among the specific infections, mumps occasionally causes an inflammation of the pancreas with considerable enlargement. Tuberculosis is very uncommon in the pancreas. Syphilis typically causes marked shrinkage, but occasionally it produces small nodules throughout the head and body, although on rare occasions large masses have been described. Rarely large gummas of the pancreas have been reported.

*Group 3.* Meconium ileus is a condition in which meconium becomes inspissated in the gastrointestinal tract and acts as a plug, producing intestinal obstruction. It is believed to be due to congenital stenosis of the opening of the pancreatic duct. This is followed by dilatation of the duct system with atrophy and fibrosis of the parenchyma leading to cystic fibrosis of the pancreas. Lack of pancreatic juice results in a failure to digest the fats and proteins in the meconium, which is the most likely reason for the inspissation. There may be an asso-

outer convex border of the descending duodenum due to a posterolaterally placed dilated common duct secondary to carcinoma of the ampulla. *O*, extrinsic pressure defect on the descending duodenum due to enlarged gallbladder, in a case of carcinoma of the ampulla, in which the common duct was normally placed. *P*, carcinoma of the head of the pancreas in an annular pancreas, which causes stenosis of the duodenum near the junction of the descending and inferior horizontal portions.

ciated pulmonary fibrosis. In cystic fibrosis of the pancreas a sprue-like small bowel pattern is found.

In acute hemorrhagic pancreatitis the pancreas may become markedly swollen, soft, boggy, and produce effects on adjacent structures. In addition, because of the seepage of some of the pancreatic ferments into the peritoneal cavity, irritation of the psoas muscle and alteration of diaphragmatic movements can be demonstrated with abnormality in gastrointestinal function.

Fat necrosis may occasionally cause peritonitis.

*Group 4.* These lesions are merely mentioned for the sake of completeness. They do not cause any change within the pancreas that could be demonstrated roentgenographically.

(a) Diabetes mellitus.

(b) Hemochromatosis.

(c) Chronic pancreatitis without demonstrable calcification. Occasionally it has been reported that this lesion may cause pressure defects on contiguous structures. However, this seems unlikely when one considers the pathological changes, which consist of atrophy, shrinkage, and considerable

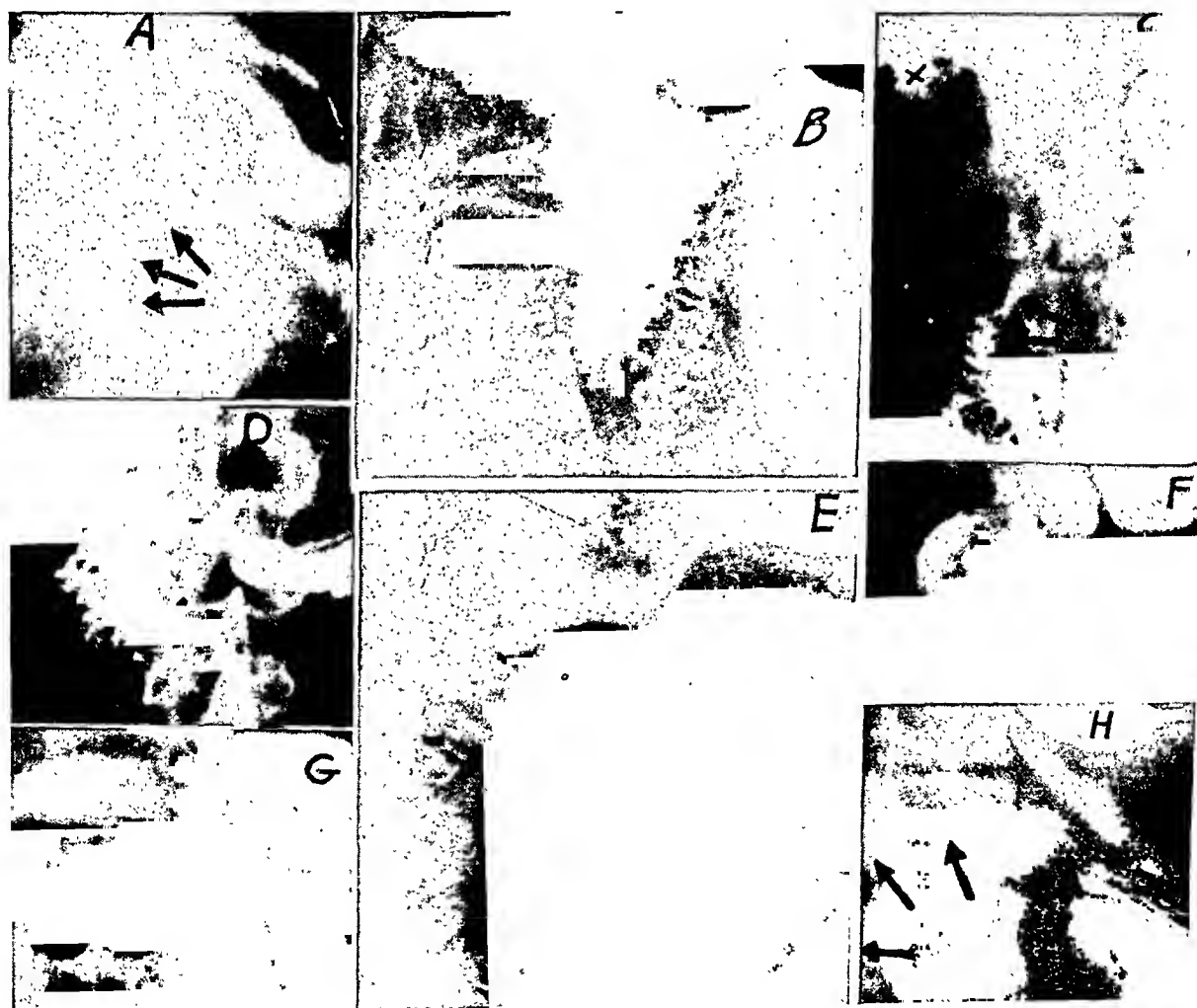


FIG. 4. Deformities of the inner concave border of the descending duodenum produced by: *A*, metastatic nodes from a neuroblastoma of the left suprarenal gland—right lateral view; *B*, enlarged tuberculous nodes; *C*, upward traction of the duodenum about the pancreatic head by a stomach herniated up through the diaphragm—note the ulcer on the lesser curvature of the pars media of the herniated stomach—marked *x*; *D*, enlarged lymph nodes in a case of proved infectious mononucleosis. The enlarged nodes were absent on re-examination four weeks later and again in five months; *E*, retroperitoneal follicular lymphoblastoma; *F*, simple cyst of the head of the pancreas; *G*, carcinoma of the mid-portion of the common duct; *H*, amyloidosis.



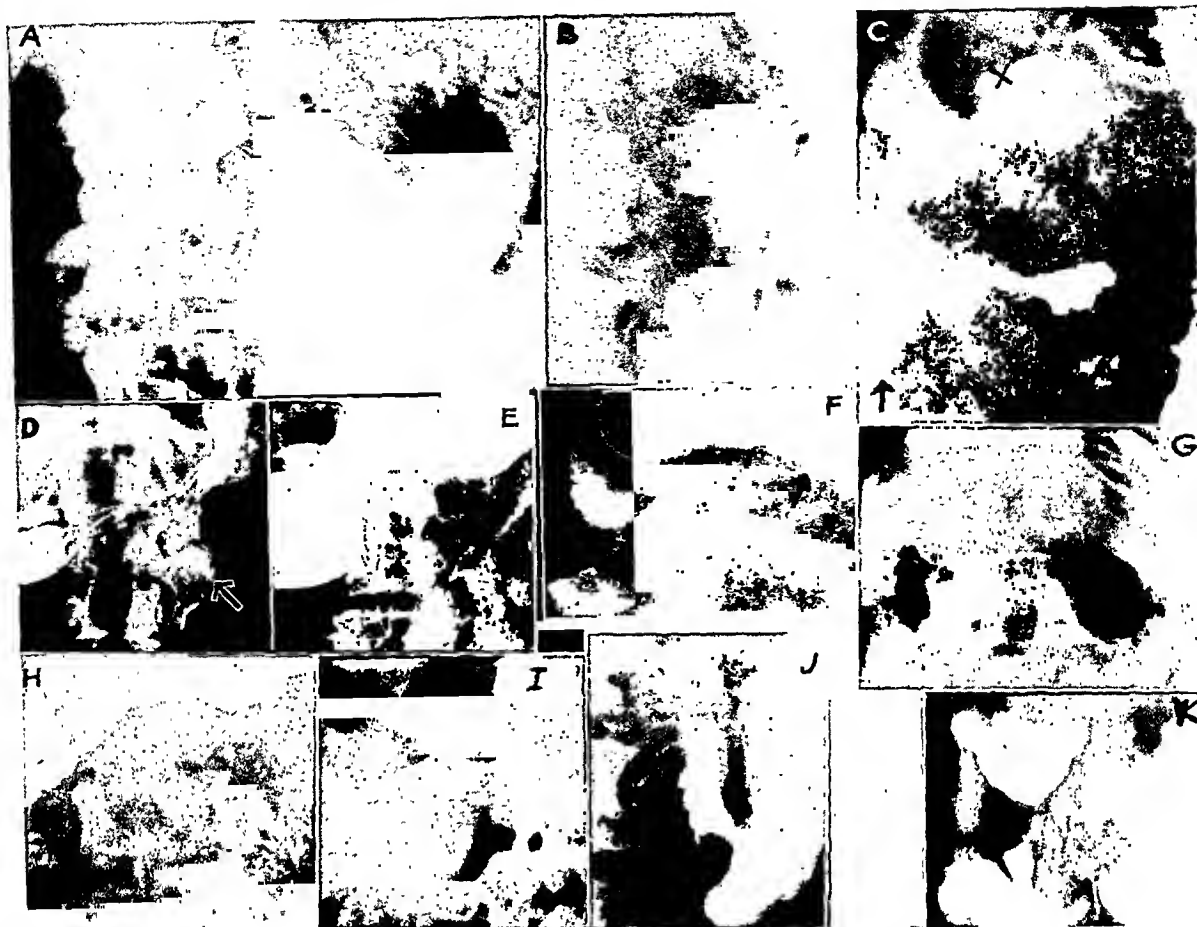


FIG. 5. *A*, pancreatic calculi, posteroanterior view. *B*, same case, lateral view. *C*, enlarged duodenal loop due to pancreatitis—note several calculi near arrow in common duct. Incidentally, note large diverticulum arising from the posterior wall of the cardiac end of the stomach—marked *x*. *D*, aneurysm of the abdominal aorta with small amount of barium in the stomach. *E*, same case with larger amount of barium in the stomach, showing defect on greater curvature. *F*, defect on greater curvature of the pylorus, which was due to a melanocarcinoma secondary to a similar lesion in an eye previously removed. *G*, carcinoma of head and body  $2\frac{1}{2}$  inches in diameter. *H*, cyst of the greater omentum, just below the stomach. *I*, several small calculi in the terminal portion of the main pancreatic duct. *J*, carcinoma of the body indenting the stomach. *K*, carcinoma of the pylorus with perforation into the pancreas—note the extraluminal barium.

connective tissue replacement of the parenchyma. Hence, when a chronic pancreatitis exists with enlargement, an associated carcinoma should be considered.

(d) Small retention cysts, small cystadenomas, tumors of the islands of Langerhans, and idiopathic hypoplasia.

#### ROENTGEN MANIFESTATIONS

Except for functional changes, which are now used more for their suggestive value, direct roentgen signs (such as obvious dense masses seen on the simple roentgenogram, calcifications, opaque foreign bodies, or collections of gas with fluid levels in the up-

right or lateral recumbent postures), the roentgenologic criteria of pancreatic disease depend almost entirely upon the presence of a pressure defect. They simply signify pressure from enlargement of the normal regional structures or pressure from the formation of adventitious space-occupying masses. The manifestations are therefore not pathognomonic for any single lesion.

The larger the mass and the nearer it is to the contrast-filled stomach or bowel, the easier will be its detection. A small mass contiguous to the contrast-filled stomach or bowel may be detected earlier than a large mass more removed, because of its early

indenture or invasion of these structures. The corollary also is obvious, i.e., that disease in and around the pancreas which does not enlarge the pancreas or the regional lymph nodes is impossible of detection roentgenographically because of the absence of a mechanical pressure defect.

With few exceptions it has become our practice to report simply that there is evidence of "an abnormal mass in the region of the pancreas," avoiding a specific statement of its nature. Some cases may present characteristic clinical or laboratory findings which will permit a precise diagnosis.

For these reasons the roentgen findings will be discussed on the basis of the anatomical location of the lesions, and fall therefore into two groups: (1) Lesions in the head of the pancreas. (2) Lesions in the body or tail of the pancreas.

*Group 1.* The following signs point to the presence of a mass in the region of the head of the pancreas:

(a) Enlargement or spreading out fanwise of the duodenal loop or widening of the semicircular arc described by the duodenum. It is important in evaluating this sign to exclude apparent enlargement due to a hypersthenic habitus in which the stomach is high and almost horizontal in position and the duodenal loop is fully exposed and therefore appears to be enlarged. Apparent enlargement alone consequently is less significant in the hypersthenic. In these individuals it is mandatory to demonstrate, in addition, some evidence of extrinsic pressure on the inner concave border of the descending duodenum or on the greater curvature side of the duodenal bulb or pylorus. The extrinsic pressure, by its rounding or ironing-out effect, changes the direction of the mesial ends of the duodenal mucosal folds (*valvulae conniventes*). With severe pressure the pattern of the *valvulae conniventes* may be greatly altered or even lost. The extrinsic pressure defect may be localized above or below the ampullary region or may be general and include the entire inner concave border of the descending duodenum, either as one smooth, rounded-

out contour or as multiple scallop-shaped defects. The large, smooth, rounded defects are more likely to be due to cysts.

(b) Displacement of the duodenal loop towards the right and anteriorly by space-occupying masses in the region of the pancreatic head. The displacement may be either general and uniform or simply a localized indentation on the lower concave border. The stomach may be displaced upward and forward if the lesion is large.

(c) Fixation of the duodenal loop, especially its medial wall. This may impair the normal expansion.

(d) Diminished caliber of the duodenal lumen, causing obstruction and delay in the emptying of the stomach.

(e) Irregularity of the contour of the inner concave border of the descending duodenum, with or without alteration or destruction of the mucosal pattern. The cases causing destructive changes are most apt to be carcinomatous.

(f) Alteration of duodenal peristalsis. This may be diminished, absent, or antiperistalsis may occur.

(g) Palpable mass.

(h) Downward and forward displacement of the transverse colon.

(i) An extrinsic pressure defect on the outer wall of the descending duodenum, in cases of common duct obstruction. It was our impression previously that this was due to a distended gallbladder. However, in a pathological study we found that it may also be due to a distended, unusually placed common duct. As described and illustrated in the section on *Anatomy*, the common duct may enter the papilla of Vater in many ways. When the common duct becomes greatly dilated in Position III it will press the duodenum forward and medially. When the common duct is in Position I it will not produce this effect. Various intermediate degrees of indenture may result, depending upon the entrance point of the papilla of Vater. An attempt was made at postmortem to inject the common duct to see whether this defect could be reproduced, but the resiliency of the duct prevented a satisfactory study. Speci-

mens removed at operation en masse, however, substantiated our assumption. This finding, therefore, in a patient with a painless increasing jaundice, in whom no abnormality is found on the inner concave wall of the duodenal loop, suggests an obstruction at the ampulla or in the lower portion of the common duct.

(j) Kirklin has described a case with a central filling defect in the duodenal bulb

(l) Case described the following signs which he has found of particular use in the diagnosis of acute inflammations of the pancreas: Elevation of the stomach, transverse position of the duodenal bulb with or without enlargement of the duodenal loop, collection and stasis of appreciable quantities of contrast material in the dependent portions of the duodenum, fullness between the stomach and transverse colon, limita-

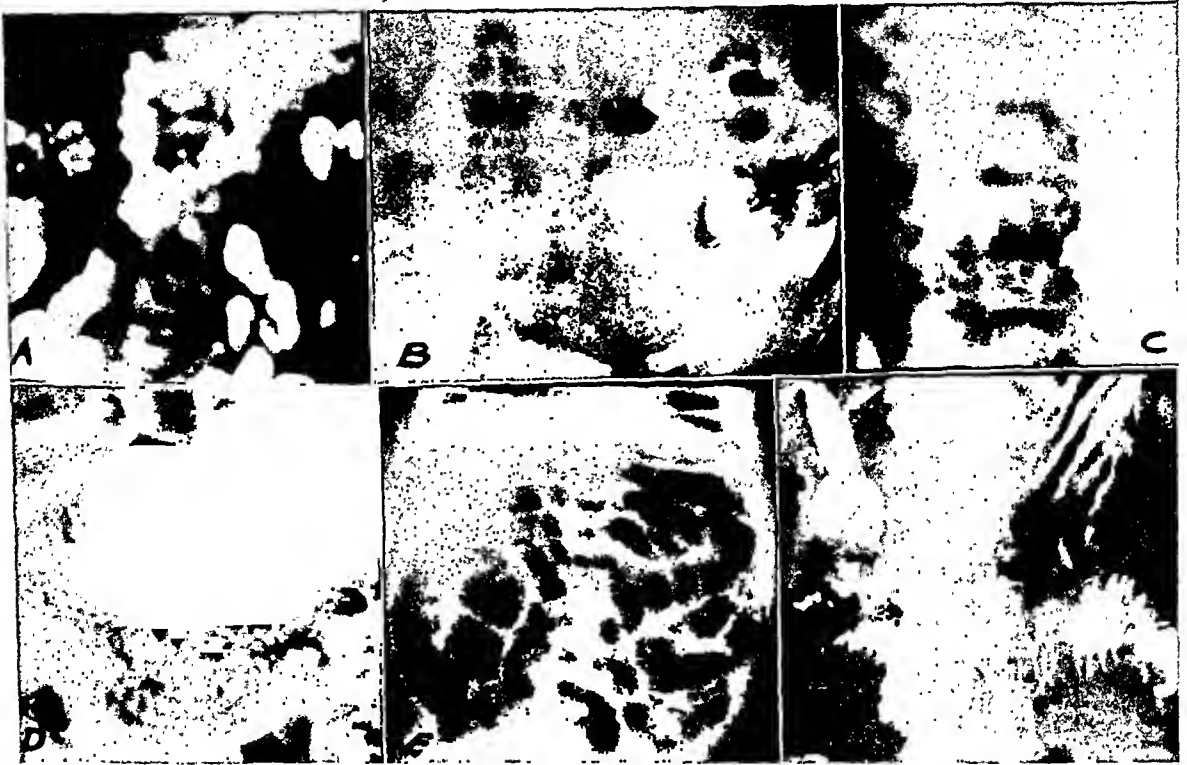


FIG. 6. *A*, small bowel "deficiency pattern"—child with known pancreatic deficiency. *B*, similar pattern in an adult with known pancreatic deficiency. *C*, irritability of the duodenum in a case of parotid mumps with abdominal tenderness. This perhaps tends to indicate involvement of the pancreas by a similar lesion. *D*, round worm in the duodenum—note barium in the intestinal tract of the worm. *E*, meconium ileus. *F*, small bowel pattern after a Whipple operation for carcinoma of the pancreatic head.

which had the appearance of an intrinsic polypoidal lesion. This, however, was caused by a pancreatic nodule impinging on the lumen of the duodenum from behind.

(k) After cholangiography in the presence of a mass in the pancreatic head there is no filling of the lower portion of the common duct, which is usually cut off abruptly and often in a transverse diameter rather than a tapering or funnel-shaped pattern. The patent proximal portion of the common duct and the cystic duct are widened.

tion of excursion of the left diaphragm, formation of pleural exudates, ill-defined left psoas contour, pressure indentations on the stomach and duodenum, coarsely feathered duodenal mucosal relief, abnormal gas distention of the colon, and even a paralytic ileus with the formation of fluid levels when the patient is examined in the erect or lateral recumbent postures.

*Group 2.* The following signs point to the presence of a mass in the region of the body or tail of the pancreas:

(a) The stomach is displaced and indented in a forward, upward or downward direction, producing a varying degree of compression, with or without obstruction. The type of roentgen manifestation is greatly influenced by the habitus and exact location and size of the abnormal mass. A mass in the region of the pancreatic body may cause an indenture on the lesser curvature of the stomach in a hyposthenic individual, while a similar appearing mass is more apt to produce an indenture on the greater curvature of the stomach in a hypersthenic individual. It is therefore evident that the fundamental disposition and variance of the viscera and their interrelationship, as determined by body habitus, influence to a great degree the roentgenological manifestations of a mass in the region of the pancreatic body or tail and should always be borne in mind when the cause for the abnormality is considered.

(b) The mid-transverse colon is displaced forward and downward.

(c) The ascending duodenum and the duodenojejunal flexure are displaced and indented in a forward, downward or upward direction, producing a varying degree of compression and obstruction. The duodenum proximal to the indented area may be dilated.

#### DIFFERENTIAL DIAGNOSIS

Lymphosarcoma, leukemia, Hodgkin's disease, metastatic tumors, tuberculosis, giant follicular lymphoblastoma, and infectious mononucleosis may cause considerable enlargement of the regional lymph nodes, producing roentgen signs which are indistinguishable from those caused by intrapancreatic masses of similar size.

Aneurysms arising from the anterior wall of the upper portion of the abdominal aorta may extend forward and simulate a pancreatic mass. These aneurysms may show linear or curvilinear calcifications.

Omental cysts, calcified or not, may be found along the lesser or greater curvature of the stomach, causing extrinsic pressure defects which are indistinguishable from intrapancreatic masses.

Diaphragmatic hernia of the stomach may cause upward traction upon the duodenal loop with pressure on the inner concave border. If the hernia is marked the pancreas may be in an ectopic position.

Intussusception of the stomach into the duodenum can deform the latter so that a pancreatic mass may be simulated.

Exogastric lesions (extramucosal) such as myosarcoma, leiomyoma and metastatic tumors in the stomach wall may cause masses which resemble pancreatic masses and cannot be differentiated.

Carcinoma of the papilla of Vater or of the lower portion of the common bile duct clinically may simulate a mass in the pancreatic head. In the latter, roentgenographically there is usually found enlargement, displacement or encroachment upon the duodenal loop.

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# ROENTGENOLOGIC OBSERVATIONS IN MESENTERIC THROMBOSIS\*

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THE authors as roentgenologists wish to describe their observations of the roentgen examinations in 3 proved cases of superior mesenteric thrombosis. Briefly, there was one common and striking finding in the plain roentgenogram of the abdomen in these cases which we believe has some diagnostic merit: namely, distention of small bowel and the right half of the colon, simulating the criteria of a mechanical obstruction. The gas collection ended abruptly at the left end of the transverse colon. The distended bowel corresponded to the distribution of the superior mesenteric vessels. In 1 case, a barium enema was given and, to our surprise, no mechanical lesion was found although expected by the sharply demarcated distention down to the splenic flexure as noted in the flat roentgenogram of the abdomen. This observation suggests the possible value of a sign-complex in the diagnosis of superior mesenteric occlusion: the free passage of the barium through a section of intestine so distended as to otherwise suggest a mechanical obstruction.

Historically, the clinical entity of mesenteric thrombosis has been known for over one hundred years. Statistics show that the mortality is high and the preoperative diagnosis rare. Due to simulation of other abdominal disease, notably intestinal obstruction, it is difficult to recognize in its earlier stages "when surgery should offer a very excellent prognosis," as Donaldson and Stout<sup>3</sup> believe. Observers have reported that complete gangrene of the bowel with bloody ascites did not occur until eighteen hours after the onset of symptoms. Examination of the literature reveals that roentgenologic examination of the abdomen in this disease is very infrequent.<sup>2</sup> Douglas<sup>4</sup> describes a case in which "the location and

extent of the lesion was demonstrable by the plain film of the abdomen." He observes that of 92 cases reviewed by Myers in 1931 in none was a plain roentgenogram of the abdomen taken to determine the presence of gas. In a survey of the literature by Bowen and Felger<sup>2</sup> in January, 1942, no mention is made of roentgen examination in the cases reported. In 1940 Berman and Thornton<sup>1</sup> described a case in which a roentgenogram taken the day before operation showed "marked distention of the small intestine." But how common is intestinal distention in mesenteric thrombosis, if roentgen study is to be of any value? The literature tells us that distention as a symptom in this disease was present clinically in 48.3 per cent in the Mayo Clinic series, in 65 per cent of cases reported by Cokkinis, in 78 per cent by Jackson, Porter and Quimby, and in 27 of 36 cases reported by Blackburn. In 9 cases in which laparotomy was done, Loop found the intestinal lumen to be "extremely relaxed." Bowen and Felger state: "With infarction, the intestine becomes purple-black in color, loses its elasticity and lustre, then progresses to the final stage of gangrene and peritonitis."

The pathogenesis of this disease has been well described by many authors. The general causes of mesenteric thrombosis have been classified as cardiovascular, infectious, mechanical and traumatic.<sup>5</sup> It is reported that the average incidence of occlusion of the mesenteric arteries is only slightly greater than venous occlusion. Occlusion of the superior mesenteric artery is said to be forty times more frequent than block of the inferior mesenteric artery.

Following are the roentgen findings and case reports of 3 patients who had mesen-

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FIG. 1. Case 1. Distention of the small intestine and the proximal half of the colon. The sharp demarcation of the gas column suggests a mechanical block near the splenic flexure. The distended intestine corresponds to the distribution of the superior mesenteric vessels.

teric thrombosis. One patient died before surgical intervention and the other 2 cases made normal recoveries after resection of gangrenous bowel.

#### CASE REPORTS

**CASE 1.** A preoperative diagnosis of mechanical obstruction was made on the plain roentgenogram of the abdomen because of considerable distention of the small bowel and the right half of the colon. The gas column ended abruptly at the left end of the transverse colon. The distal part of the colon was empty of gas. The sharp demarcation of the distended gut suggested a mechanical block, and a barium clysma was given for confirmation. To our great surprise, the opaque mixture passed readily through descending, transverse and ascending portions of the colon. Two changing areas of spasm were noted in the sigmoid, probably reflex from peritoneal irritation. The patient's general condition was considered un-

satisfactory for operation and death occurred the next day. Autopsy revealed a thrombus in the superior mesenteric artery, with gangrene of the entire small bowel and the right half of the colon. The purplish gangrenous gut tapered off gradually to a normal appearance as the mid-transverse colon was approached.

F.B., Russian Hebrew, female, aged seventy-five years. The patient was admitted to Kings County Hospital, Brooklyn, New York, in October, 1942, with complaints of obstipation and abdominal pain, for a duration of two and one-half days. The clinical diagnosis on admission was intestinal obstruction. Frequent vomiting, not fecal in content, had persisted since the onset. No bowel movements after cathartics and enemas. Abdominal distention marked in the last twenty-four hours.

The past history disclosed an old hernia, with the use of a truss. Also indefinite weight loss in the last six months. Recently the patient had been taking one tablet of digitalis daily, with a story of ankle edema and hypertension.

Physical examination showed an aged white



FIG. 2. Case 1. The barium enema flowed freely through the entire colon. No mechanical lesion. Autopsy showed gangrenous intestine due to mesenteric thrombosis.



woman in acute abdominal distress. No dyspnea or orthopnea.

The heart was moderately enlarged to percussion. A soft systolic murmur was present over the apex. The heart rate was 110, and totally irregular. There was no pulse deficit.

The abdomen was distended. There was slight tenderness throughout the abdomen, especially on the left side. No borborygmi were heard. There was no rebound tenderness or rigidity and the abdomen was soft. A small hernia was palpated in the right inguinal region.

The rectal examination showed external hemorrhoids.

There was one plus ankle edema. Arthritic changes were noted.

The temperature was 99° F.; respiratory rate 24; blood pressure 160 systolic and 90 diastolic.



FIG. 3. Case II. Distention of the small intestine and proximal half of the colon corresponding to the distribution of the superior mesenteric vessels. The distention simulates a mechanical lesion. Three feet of gangrenous ileum removed, with recovery of the patient. Hemorrhagic infarction in small bowel.



FIG. 4. Case III. Distention of proximal colon down to splenic flexure. Four feet of gangrenous ileum removed, with recovery. Venous thrombosis found.

Surgical intervention was postponed because of fibrillation, dehydration and poor general condition.

On the day after admission, follow-up notes record the condition of cardiac failure, with fibrillation. The abdomen was moderately distended but soft, with tenderness mostly confined to the left lower quadrant. No masses were felt. Rectal examination showed feces present. Temperature was normal. Leukocyte count was 10,400; erythrocyte count, 3.9 million; hemoglobin, 75 per cent.

Another clinician recorded that there was no visible or audible peristalsis. Paralytic ileus or volvulus was also considered in the differential diagnosis.

Electrocardiogram showed auricular fibrillation and myocardial damage. Urinalysis showed a few granular casts, a few red blood cells and leukocytes, two plus albumin, no sugar.

The patient died the following day.

*Autopsy Findings.* There was about 150 cc. of a brownish-yellow fluid in the abdominal cavity. Both large and small intestines were



markedly distended. The entire small intestine, the cecum and ascending colon were dark purple in color and appeared gangrenous. The gangrenous area in the cecum and ascending colon gradually diminished in severity and in intensity as to color as one progressed distally. Many loops of small intestine were loosely adherent to each other and to the floor of the pelvis by a yellow plastic material. No evidence of herniation of any part of the intestines.

The gastrointestinal tract was then opened from the esophagus to the rectum.

The entire small intestine and cecum showed a purplish mucosa. On section the entire wall of the above intestine showed a gangrenous purplish surface. The superior mesenteric artery was traced throughout and about 2 inches distal to the aorta at the base of the mesentery of the small intestine, a large thrombus was found, about 3 inches in length, completely occluding the artery. There was no evidence of cancer in the small or large intestine.

#### *Anatomical Diagnosis:*

1. Thrombosis of the superior mesenteric artery with gangrene of the small bowel, cecum and part of the ascending colon.
2. Hypertensive arteriosclerotic heart disease.
  - (a) Myocardial hypertrophy.
  - (b) Arteriosclerotic mitral sclerosis.
  - (c) Atherosclerosis of the aortic valves, moderate.
  - (d) Coronary sclerosis, marked.
3. Atherosclerosis of the aorta, marked.
4. Arterial nephrosclerosis.
5. Nutmeg liver.
6. Emphysema of the lungs.

CASE II. In this case a plain roentgenogram was obtained preoperatively and a diagnosis of possible mesenteric thrombosis or obstruction was offered by the striking resemblance to the findings in Case I, namely, distention of the small intestine and proximal half of the colon, with an abrupt stop to the air column at the left and of the transverse colon. Operation was performed before any further roentgen investigation was made and 36 inches of gangrenous gut was resected with findings of extensive hemorrhage and vascular engorgement of the mesentery.

J. A., white Italian female, aged eighteen. The patient was admitted in July, 1943, with complaints of abdominal pain, vomiting and

rectal bleeding for a period of eighteen hours since the onset. The pain started in the epigastrium and then localized to both lower quadrants. It was colicky in type, persistent, with cramp-like exacerbations mainly in the left lower quadrant, and radiated to the back. The patient had vomited all ingested food and fluids since the onset. One bowel movement occurred. A subsequent enema was nonproductive. Later the patient passed maroon-colored blood by rectum on two occasions. The pain became progressively worse.

There was a history of syphilis and a positive Wassermann reaction.

No previous similar attacks had been experienced. The patient had just completed a menstrual period, which was normal. An appendectomy was performed four months prior to this admission.

Physical examination of the abdomen revealed a healed scar in the right lower quadrant. The upper portion of the abdomen was scaphoid, and the part below the umbilicus was distended. The liver, spleen and the kidneys were not palpable. The abdomen was diffusely tender, with rebound most marked in the lower quadrants. No masses were felt. Borborygmi were heard over the lower quadrants. The patient appeared poorly nourished and anemic. The general condition was said to be not good. The heart and lungs were negative.

The clinical diagnosis was acute intestinal obstruction with strangulation.

At operation a large amount of serosanguineous material was found in the abdomen and a considerable amount of gangrenous gut. Three feet of ileum were resected and an ileostomy done.

*Pathological Report.* Gross: "The specimen consists of approximately 36 inches of intestine, with a small portion of mesentery attached and showing several loops. The serosal surface is dull gray, dark brown and bright red in other areas. It appears to contain some gas and has a fetid odor. On section, the specimen emits bloody fluid. The mucosal surface is dull and brown in color, and shows some irregular greenish-brown areas."

Microscopic: "Section of small bowel characterized by marked mural edema, congestion, hemorrhage and necrotizing changes involving all coats. Areas of infiltration with polymorphonuclears and lymphocytes noted. The mesentery is likewise the seat of extensive

hemorrhage, vascular engorgement and infiltration with leukocytes. Diagnosis: hemorrhagic infarction of small bowel."

A secondary operation was done at a later date to establish bowel continuity following ileostomy.

The patient made a complete recovery.

CASE III. In this case also, a preoperative plain roentgenogram of the abdomen showed distention of the right half of the colon down to the splenic flexure, while the colon distal to this was not dilated. The attending surgeon had made a clinical diagnosis of mesenteric vascular occlusion and operated immediately before further roentgen studies were obtained. Operation disclosed mesenteric thrombosis. The patient recovered after bowel resection.

M. F., colored laborer, aged thirty-nine, admitted on February 19, 1943, to Kings County Hospital for treatment of a hematoma of the buttock, following trauma. Blood was evacuated from a cystic hematoma of the right buttock eighteen days after injury. The past history was negative save for a neisserian infection five years before.

One week after the operation on the buttock, the patient experienced sudden cramping lower abdominal pain after an enema. Vomiting and tenesmus were present. The abdomen was soft and not tender. The clinical impression was gastroenteritis. The temperature was 100.6° F., pulse 86, respirations 26, blood pressure 112/96.

Another observer: The abdomen was mildly distended, with a tympanitic note heard throughout except the left lower quadrant and the left flank where the note is flat. Dullness does not shift. Pain and tenderness in these same areas. No spasm or rebound. Rectal examination showed no tenderness, no blood, tonus good. Impression: Intestinal obstruction, hemorrhagic in origin. Clotting time was 5 $\frac{3}{4}$  minutes (Lee and White method).

Another observation at 9:45 P.M.: Patient in no acute pain but still has distention. High soap suds enema ineffectual. Leukocyte count 28,000, with 90 per cent polymorphonuclears. Therapy: Harris drip, infusion, Wangenstein tube.

At 10:45 P.M.: Patient complains of hiccough. In no acute pain. Abdomen still distended, tender in left upper quadrant and down the left side. Occasional peristaltic sound heard on auscultation. Diagnosis by Dr. Laurence G. Bodkin (service of Dr. Joseph Tenopyr): "Soft

distention, high blood count, absence of definite obstructive symptoms. Opinion: mesenteric vascular occlusion."

At operation (March 10, 1943) there was found gangrene of the ileum to within 4 inches proximal to the cecum. The ileum was blackish in color, with thrombosis of the mesenteric vessels. Free, thick, colorless fluid in large amounts. Four feet of ileum was removed.

*Pathological Report.* Specimen consists of a piece of small intestine which measures 51 inches in length. The serosal surface is dark brown in color. The mesentery is slightly thickened. The gut feels thickened in its entirety. There is a markedly edematous mucosa and an easily friable wall.

*Microscopic:* Very marked mural edema of small gut with congestion and extensive interstitial hemorrhage, especially marked in the mesentery. Areas of polymorphonuclear invasion together with focal areas of necrosis noted. The findings were considered to indicate venous thrombosis, probably due to mechanical cause.

The patient made a normal recovery.

#### SUMMARY AND CONCLUSIONS

The preoperative diagnosis of mesenteric thrombosis is difficult, yet its early recognition offers an excellent opportunity for bowel resection and complete recovery.

Roentgen examination of the acute abdomen and in this particular disease has in the past been too often neglected by the attending physician and the surgeon.

The clinical finding of distention is very common in mesenteric thrombosis, according to the literature.

Three proved cases are reported in which the most striking roentgen finding was localized distention of the intestine simulating a mechanical obstruction, but having a distribution which corresponded to that of the superior mesenteric artery, with an abrupt demarcation of the distended intestine near the splenic flexure of the colon. In one case a barium enema passed freely through the distended intestine. One patient died. The other two patients made a complete recovery after bowel resection.

Although these are new concepts, the roentgen findings in our three cases suggest

that the possible diagnosis of thrombosis of the superior mesenteric vessels should be among those considered when the plain roentgenogram of the abdomen discloses bowel dilated down to the region of the splenic flexure, simulating a mechanical obstruction. If a subsequent barium enema reveals no obstruction, it is believed that the diagnosis may be ventured with some probability.

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# GIANT HEMANGIO-ENDOTHELIOMA WITH THROMBOCYTOPENIC PURPURA

## RESULTS OF ROENTGEN THERAPY

By ADRIAN W. RHODES, M.D.\*, and F. J. BORRELLI, M.D.†  
NEW YORK, NEW YORK

**G**IANT hemangio-endothelioma associated with thrombocytopenic purpura is a combination of great rarity. Only one other comparable case has been reported in the medical literature. This unusual case is presented first, because of the rarity of its occurrence, and second, because of the excellent therapeutic results obtained from roentgen therapy.

J. D., an infant, aged six months, was admitted in critical condition to the Flower and Fifth Avenue Hospitals by transfer ambulance from Metropolitan Hospital. Transfer was considered necessary because the tumor on the child's back suddenly began to swell. This enlargement was accompanied by a tendency to hemorrhage. The infant was admitted to Flower and Fifth Avenue Hospitals for deep roentgen therapy.

On admission, the patient was a well developed and well nourished white male infant who was deformed by an extensive tumor covering the upper half of his chest, anteriorly and posteriorly, on the left side, and extending across the neck onto the lower part of the face, and also on the left arm. The tumor was firm and did not pulsate. It showed no areas of degeneration or infection. There was, however, a small healing wound at the point of the left shoulder where a part of the tumor was excised for biopsy. The tumor was ecchymotic and had a blue discoloration. There were hemorrhagic spots around the base of the tongue, soft palate, fauces and pharynx. No actual hemorrhage was discerned. The spleen was palpable one finger breadth below the costal margin. The remainder of the physical examination was negative.

The child's mental development was average for his age. The family history was not contributory.

The laboratory findings at this time were: Complete blood count—hemoglobin 9.2 grams; red cells 3 million; white cells 15,200; platelets

15,000 by direct method; coagulation time four minutes; bleeding time twenty-five minutes. The Wassermann reaction was negative. A roentgenogram of the left shoulder and neck was taken on May 7, 1942, and showed evidence of the soft tissue tumor mass but no evidence of bone or joint disease.

The child was born at home on November 21, 1941, by spontaneous delivery (breech) and was a full term 7½ pound normal white male. At birth a crescentic mass was noted on the back extending from the midline to the left shoulder and the diagnosis of "lipoma" was made.

In January, 1942, the tumor became larger and showed a bluish discoloration which blanched on pressure. Small areas of ecchymosis and petechiae were noted all over the body.

He was admitted to New York Hospital on March 5, 1942, where the initial laboratory reports revealed low hemoglobin, low red blood count, markedly diminished platelet count and prolonged bleeding time. Here the diagnosis of hemangioma with thrombocytopenic purpura was made. The mass continued to increase in size with marked discoloration despite vitamin K and numerous small transfusions. One treatment of deep roentgen therapy, 220 r at 140 kv. (peak) with 1 mm. Al filter at 25 cm. distance, was given without appreciable effect.

One week later the infant was admitted to Metropolitan Hospital where the laboratory findings were similar to those found at New York Hospital. Here the child was given supportive therapy including blood transfusions and vitamin K. The mass gradually extended to the left side of the face and chin and down to the last rib on the left side (Fig. 1 and 2).

On May 4, following an upper respiratory infection his throat became hemorrhagic. The uvula was edematous and showed hemorrhagic spots.

The next day the pharynx was more hemorrhagic with many spots that bled easily. The child now had a laryngeal cry and looked criti-

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cally ill. It was deemed advisable at this time to refer the child for roentgen therapy, and he was therefore transferred to the Flower and Fifth Avenue Hospitals.

The first two courses of deep roentgen therapy were given between May 8 and June 30, 1942.

The first course, given from May 8 to June 1, consisted of a total of ten treatments of 100 r each through portals of 7 by 7 cm. and 10 by 10



FIG. 1

cm. using 140 kv. (peak) through 3 mm. Al filter at a distance of 50 cm. The whole tumor was not treated at one time but was marked off into four major sections, each area receiving 200-300 r, measured in air, as follows (slight overlapping could not be avoided): (1) laterally to left side of neck—300 r; (2) laterally to left shoulder—200 r; (3) left shoulder anteroposteriorly—300 r; (4) left shoulder posteroanteriorly—200 r.

After an interval of two weeks, during which time there was but a slight regression of the tumor and no change in the blood picture, a second series of six treatments was given from June 16 to 30. Three areas were treated—the neck, shoulder anteroposteriorly and shoulder posteroanteriorly. Each area received 200 r. The same factors were used in this series as were used in the first series, with a total dosage of approximately 700 r.

Supported by small transfusions, the child showed some improvement under this therapy with some regression of the tumor mass. The abnormal bleeding time varied between eleven and thirty minutes, and the platelet count remained low, between 15 to 80,000 c. mm. The baby's physical and mental development was never at any time impaired or retarded and the child continued to develop normally.

On July 25, the growth again began to enlarge in all directions. The tumor was boggy and edematous to palpation. The blood findings at this time were as follows: bleeding time eight minutes and platelet count 240,000 per c. mm.

By August 10, 1942, the bleeding time had risen to fifty minutes and the platelets had fallen to 60,000 per c. mm. (Chart 1).

The next day new purpuric areas appeared on the chin and chest of the baby. Therefore, we decided to start another course of deep roentgen therapy but with a variation in type and dosage, as follows:

On August 11, posteroanteriorly to the back and left shoulder, a dose of 275 r, measured in air, was delivered with only the inherent filtration (approximately 0.15 mm. Cu) of the tube at a distance of 25 cm. using an open field and 160 kv. (peak).

On August 13 and September 1 to the same area 275 r was delivered through a 20 by 20 cm. portal using 160 kv. (peak) with 3 mm. Al filter, at a distance of 50 cm.



FIG. 2

On October 22, laterally to the neck and shoulder 275 r was delivered through a 10 by 10 cm. portal using 160 kv. (peak) and a 3 mm. Al filter, at a distance of 50 cm.

The child responded very well to the treatment. In two months the mass had regressed so much that the normal body contours appeared. The underlying bony prominences became palpable for the first time. The discoloration of the skin persisted and faded slowly.

On October 14 the baby developed a generalized erythematous vesiculopapular eruption. No cause could be found for this lesion. However, it started to disappear spontaneously and



FIG. 3

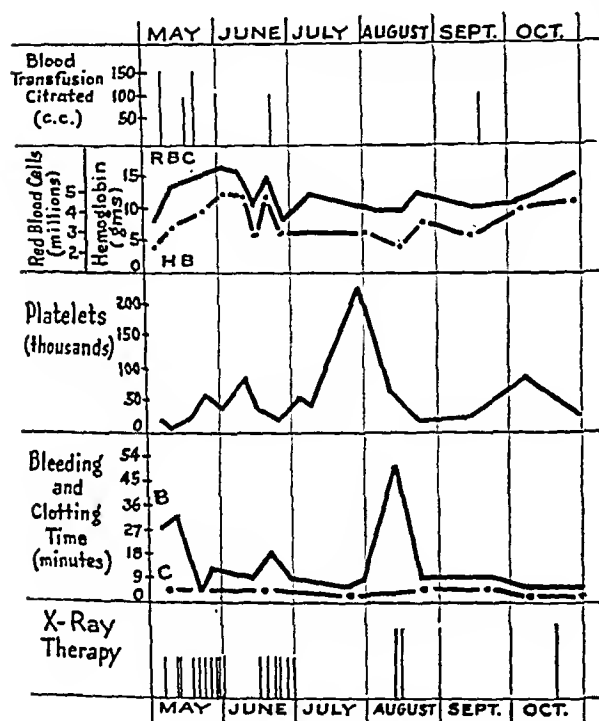


CHART I

the child was discharged from the hospital on October 31, 1942.

The report of the biopsy of the tumor taken at Metropolitan Hospital was as follows: "There are areas showing large numbers of small vessels lined by neoplastic endothelium. The lumen of the vessel is small and obliterated in some places. In these areas the tumor shows marked cellularity. Those areas are intercepted by large amounts of fat tissue. Diagnosis—hemangioma hypertrophicum (hemangio-endothelioma)" (Fig. 3).

The child was seen on March 4, 1943, one year after his admission to Metropolitan Hos-

pital (Fig. 4 and 5). At this time most of the skin had a normal appearance except for a small area on the arm which showed some purplish discoloration due to recent bleeding. In the region of the shoulder the skin is roughened, slightly raised and red. Both areas were given a single dose of 275 r through a 10 by 10 cm. portal using 160 kv. and a 3 mm. Al filter at 50 cm. distance.

One month later, on April 4, 1943, he was again examined. The purple areas had disappeared but the reddened area was unchanged. The bleeding and clotting times were four and a half minutes and one and a half minutes respectively, and the platelet count was 450,000 per c. mm. At the present time the child is developing normally. He is of average intelligence, active and alert.

In determining the type and dosage of roentgen therapy to be given to the tumor mass we had but little precedent to follow. Kasabach and Merritt,<sup>1</sup> in their case, used a combination of roentgen and radium therapy. In this patient the mass never became localized sufficiently for us to expect to get satisfactory results from the use of radium. Inasmuch as we used roentgen radiation alone we had therefore to increase the amount suggested by Kasabach and Merritt. From the effect noted in the first and second series of treatments, the amount and total radiation were apparently insufficient; however, the latent effect of the roentgen dosage could not be evaluated at



FIG. 4

this time. Therefore, larger doses were given with prompt and effective response. This response manifested itself not only in the regression of the tumor, but also in the elevation of the platelet count and in the lowering of the bleeding time with a corresponding disappearance of the purpura. Since the radiation delivered to the tumor was also effective on the spleen, ribs and long bones, it is difficult to ascertain whether the beneficial effect on the thrombocyte count was due to the roentgen therapy to the tumor alone or its additional effect on the spleen and long bones combined.

#### SUMMARY

We have presented the case of an infant who had a giant hemangio-endothelioma covering the left side of the face and the



FIG. 5

left shoulder and thorax, associated with thrombocytopenic purpura. This tumor was diagnosed by biopsy and was treated successfully with heavy doses of deep roentgen therapy which caused regression of the tumor mass and disappearance of the purpura, with a restoration of the normal blood picture.

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# DIRECT VISUAL GUIDANCE, TRIANGULATION ROENTGENOSCOPY IN THE REMOVAL OF OPAQUE FOREIGN BODIES

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THE numerous articles in regard to various methods of localization of foreign bodies, particularly those pertaining to depth measurements for guidance of the surgeon in removing them, have stimulated the reporting, in more minute detail, my experience with my own apparatus. This apparatus, previously described,\* relies on no measurements but rather on direct visual guidance at the time of operation.

In endoscopy and eye work the removal of foreign bodies cannot be done by surgical exposure, except for an extremely small opening through the wall of the eyeball. This opening must, necessarily, be no larger than enough to admit a Cross loop forceps. Of course, in the case of magnetic foreign bodies, in the eye, the usual localization guides the surgeon as to the point of application of the electromagnet. However, we see non-magnetic foreign bodies in the eye, such as B.B. shot, shot of various sizes from shot gun shells, pieces of brass or other alloys. These non-magnetic foreign bodies of the eye and opaque foreign bodies of the food and air passages are the ones with which we are concerned at this time. They present a problem in which no amount of measurement will be of even the slightest aid to the surgeon. These must be removed under direct, accurate visual guidance at the time of operation. Any method which will guide the surgeon quickly and accurately in removing such foreign bodies should facilitate, even more, the removal of those which require surgical exposure, such as bullets in soft tissue.

In the past the removal of opaque foreign bodies in the eye (non-magnetic), the food

and air passages has been accomplished by biplane roentgenoscopy. This, as anyone knows who has tried it, is cumbersome and slow. Being apparently lined up in one plane, with a biplane roentgenoscope, may be far from the foreign body in the other

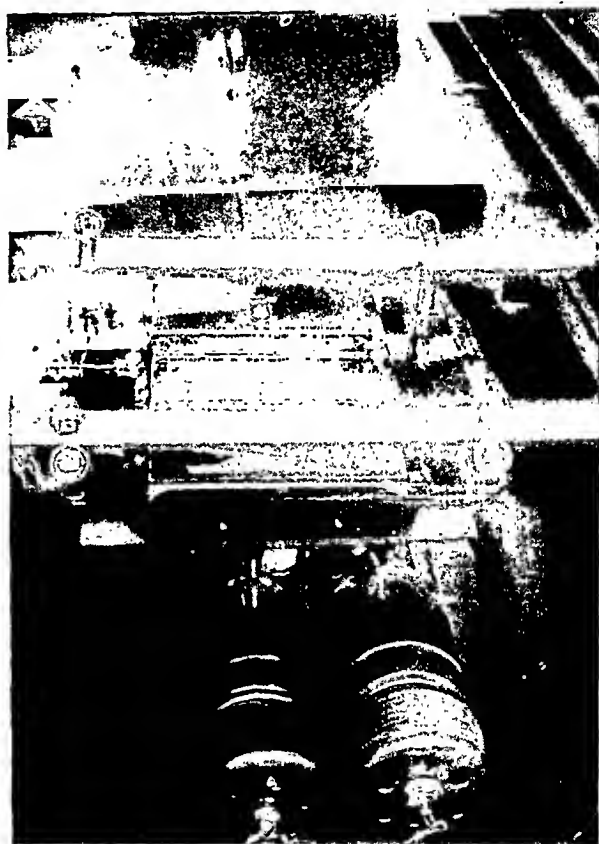


FIG. 1. Roentgenologic tilt table top removed showing the triangulation roentgenoscopic assembly. Note roentgen tubes in parallel. Three wire system to the cathodes, one wire common. Anode, one wire with short wire connecting the two anodes. One tube set so that rays are at right angle to the table top as for conventional roentgenoscopy, the other tilted slightly so that rays intersect those of the first tube for triangulation roentgenoscopy. The first tube can be used independently of the second tube by a single switch on the control panel.

\* Roberts, W. E. New method of guidance-triangulation fluoroscopy in the removal of opaque foreign bodies. *South. Med. & Surg.*, August, 1938, 100, 385-386.



FIG. 2. *A*, roentgenogram showing a finishing nail adjacent to the heart shadow in the extreme base of the right lung. Nail removed through the bronchoscope under triangulation roentgenoscopic guidance. *B*, roentgenogram made on model illustrating forceps shadows to the right of the foreign body shadows (patient on back, prone on table for all illustrations). One foreign body and one forceps but two images on the film or fluoroscopic screen in this figure and Figures 3, 4, 5, 6*B*, 7 and 8.  $D_1D$ , shadows of the foreign body;  $F_1F$ , shadows of the forceps.

plane. Biplane work requires constant shifting from one plane to the other.

This is completely overcome with my present apparatus, the triangulation roentgenoscope (Fig. 1). Only one fluoroscopic screen is used and from this any and all positions of the foreign body, forceps, or

probe can be determined. Every movement of foreign body or instrument is before the roentgenoscopist at all times, in all three planes. All three dimensions are observed as instantaneously as the pulsation of the heart in conventional single plane roentgenoscopy. Triangulation roentgenoscopy is not three dimensional in the sense of



FIG. 3. Forceps shadows farther apart than the foreign body shadows. Too far posterior, in other words forceps nearer the tubes than the foreign body.  $D_1D$ , shadows of the foreign body;  $F_1F$ , shadows of the forceps.

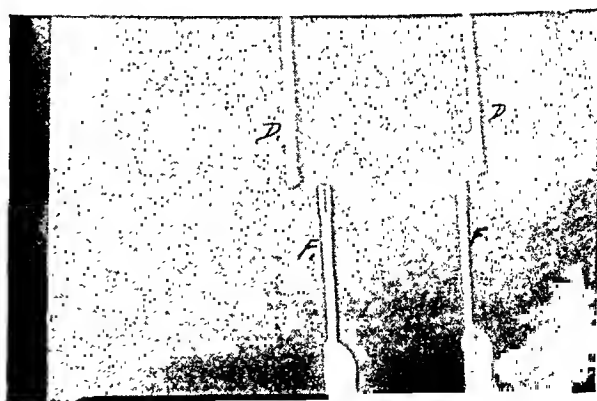


FIG. 4. Forceps shadows closer together than the foreign body shadows. Forceps too far anterior (forceps farther away from the tube than the foreign body).  $D_1D$ , shadows of the foreign body;  $F_1F$ , shadows of the forceps.

stereoscopic vision. All dimensions are obtained by positions and relations on a single screen and visible at all times.

As will be noted in Figure 1, there are two roentgen tubes mounted in parallel on a single tube carriage of special design instead of the usual single tube for roentgenoscopy. These two tubes are so mounted as to permit setting them at any desired angle. I keep one tube in the usual position used in single plane roentgenoscopy, i.e. the rays are projected at right angles to the table top. The other tube is adjusted at an acute angle so that the rays intersect those of the first tube, in other words, cross fire.

The two roentgen tubes are of identical design and capacity. They are so wired through the control panel that one or both can be used by simply turning a single hand switch. Each tube has its own filament rheostat control. The filament current is then adjusted so as to give 5 ma. on the first tube. Then the second tube is thrown into the circuit and the filament adjusted to read 10 ma. (5 ma. on each tube). The two tubes are activated simultaneously through a single foot switch and the radiation from both is projected through the same shutter assembly. This shutter assembly is of special design, having a larger portal than the usual fluoro-

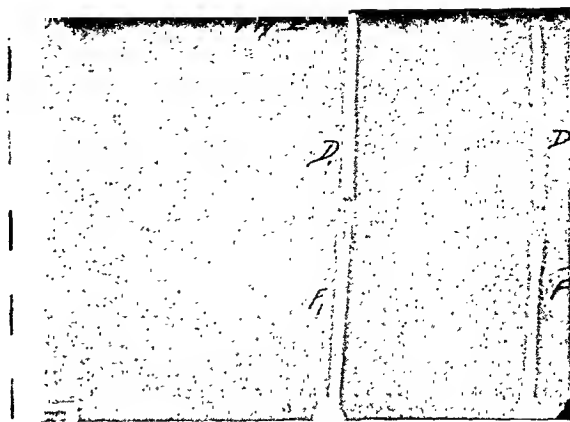


FIG. 5. Forceps and foreign body in the same plane, vertically and horizontally, because the forceps and foreign body are equidistant from the tubes.  $D_1D$ , shadows of the foreign body;  $F_1F$ , shadows of the forceps.

scopic shutters. As a result of both tubes being activated at the same time, cross fire, there are two shadows of the foreign body on the fluoroscopic screen instead of one. Any other opaque object which comes into the field, such as a pair of forceps or probe, will also produce two shadows on the fluoroscopic screen (Fig. 2B, 3, 4, 5, 6B, 7 and 8).

Consequently all that is necessary to inform the surgeon as to his instrument's position in regard to the foreign body is to observe the distance between the two shad-

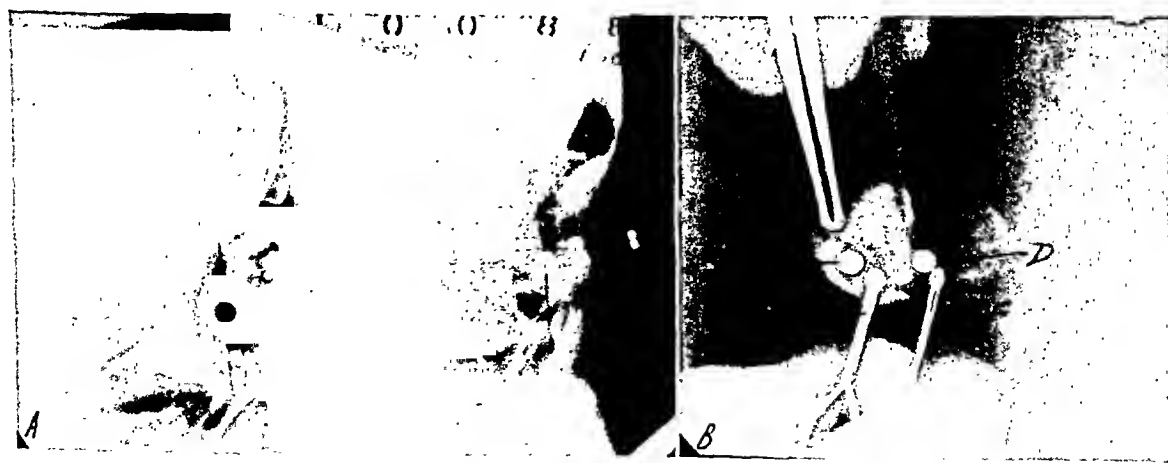


FIG. 6. *A*, roentgenograms made to determine whether B.B. shot was inside the eye or in the orbital tissue. B.B. shot was inside the eye. *B*, roentgenogram made on "dummy" model to illustrate triangulation roentgenoscopic guidance for removal.  $D_1D$ , shadows of the foreign body (B.B. shot);  $F_1F$ , shadows of Cross loop forceps. Forceps above and to the right of the foreign body.

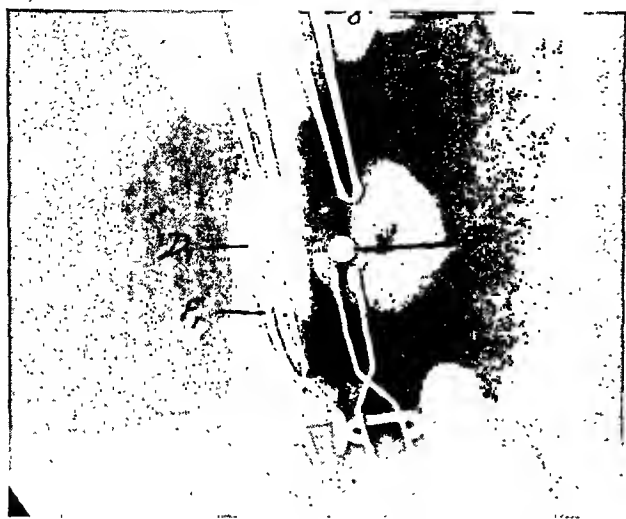


FIG. 7. Same as Figure 6B except Cross loop forceps are in the same plane as the foreign body because the shadows of the foreign body and forceps are equidistant.  $D_1D$ , shadows of the foreign body;  $F_1F$ , shadows of the forceps.

ows of the foreign body and the distance between the two shadows of the instrument. In bronchoscopy, the patient is placed on the table on his back and thus if the roentgenoscopist reports the forceps too far anterior we understand that means too far toward the ventral surface; too far posterior, too far toward the dorsal surface. Right and left are the same as the bronchoscopist's right and left. For example, in the lung, if the two instrument shadows are to the right of the foreign body shadows (Fig. 2B) the instrument is too far to the right even though it may be in the proper horizontal plane. Conversely, the same is true to the left. Now if the instrument is introduced too far posteriorly, this means that the instrument is nearer the fluoroscopic roentgen tubes than the foreign body and the two shadows of the instrument will be farther apart on the fluoroscopic screen than the two shadows of the foreign body (Fig. 3). If the instrument is introduced too far anteriorly, the instrument is farther from the tubes than the foreign body and the two shadows of the instrument will be closer together than the shadows of the foreign body (Fig. 4), just the reverse of Figure 3. When the instrument is introduced into the proper plane (the same plane

as the foreign body both vertically and horizontally, and not to the right or left), the distance between the two shadows of the foreign body and the distance between the two shadows of the instrument will be the same, and in direct apposition to each other (Fig. 5). This is true because the forceps and the foreign body are equidistant from the roentgen tubes. Now, when the instrument is advanced to the foreign body the shadows of the foreign body and the tip of the instrument are in contact because they are in the same plane in all directions. In the case of the eye we have a slightly different situation as the patient must be placed on the roentgenoscopic table on his side. All that is necessary is to decide the nomenclature of the directions so that the surgeon will understand the directions given by the roentgenoscopist. Figure 6A shows a shot in the left eye. Figures 6B, 7 and 8 illustrate, on a dummy model, the double shadows as seen on the fluoroscopic screen when using the triangulation roentgenoscope. Frequently in the eye it is difficult to approach the foreign body even though the forceps are in the proper plane because the shot will move about very freely instead of being fixed as those in a terminal bronchiole. However, once arriv-

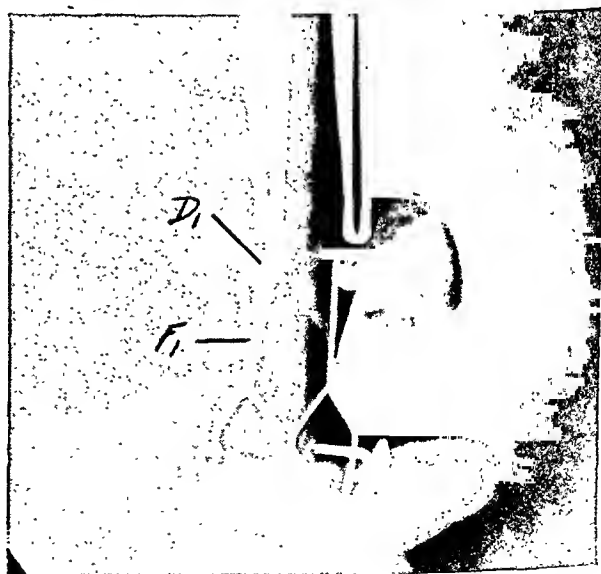


FIG. 8. Foreign body grasped by Cross loop forceps and removed.  $D_1D$ , shadows of the foreign body;  $F_1F$ , shadows of the forceps.

ing in the proper plane (Fig. 7), if the jaws of the Cross loop forceps are kept apart sufficiently the foreign body may be approached without shifting position and grasped easily (Fig. 8). Any movement out of the proper plane is quickly detected since all directions are continuously before the roentgenoscopist.

The description is necessarily long but actually only a glance at the fluoroscopic screen is necessary to determine the position of the surgeon's instrument in regard to the foreign body. Just as rapidly as the instrument is moved the roentgenoscopist who understands the underlying principle of the triangulation roentgenoscope can report to the surgeon where his instrument is in relation to the foreign body. No one plane or dimension is considered separately as in biplane or measurement. All dimensions are plainly visible at a glance at all times and the relation of the instrument and the foreign body can be described as rapidly as shadows are described in single plane roentgenoscopy.

The only other variation from the conventional roentgen table is a false table top. This is a simple wooden top elevated by wooded supports to about 10 or 12 inches above the usual table top. This false top is secured to the regular tilt table by an immobilizing band. The function of this false top is to gain distance from the roentgen tubes so as to eliminate, as much as possible, any distortion.

A calibration in roentgens is done frequently with both tubes functioning so that an accurate check can be kept on the dosage any patient receives at any given time. In addition, I have a self starting electric clock wired into the circuit so that a reading can be made at the start of roent-

genoscopy; and at any time during the operation the elapsed time may be determined and thus the number of roentgens calculated.

This method, which has been successfully used in this laboratory in numerous cases over a period of six years, has many advantages. No measurements are made or needed. This cannot be over-emphasized. The surgeon and roentgenoscopist work together as a team at the time of operation, not independently as in measurement or calculation. In some parts of the body, such as the eye (non-magnetic foreign bodies), the esophagus and the terminal bronchioles of the lung, measurements are worthless. It would seem that any method such as this one which guides accurately and quickly in such parts as the lung, food passage and eye would be very valuable where surgical exposure is indicated. The procedure gives all dimensions at a single glance, thus speeding up the whole procedure to the comfort of the patient and all concerned. The apparatus is all shock proof and a part of the roentgenologic tilt table the same as any single plane roentgenoscope. This roentgenoscopy need not exclude light in the room. A head operating fluoroscopic screen can be used just as well as the usual screen. Consequently it would seem that this method, which is rapid and accurate, being based on triangulation, could be used for the removal of any opaque foreign body anywhere in the human body.

The 2 cases\* illustrated in Figure 2A and 6A were selected from the 16 so far recorded.

\* Bronchoscopy done by Dr. V. K. Hart and eye surgery by Dr. Frank C. Smith.



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*Forty-fourth Annual Meeting:* Joint Meeting of the American Roentgen Ray Society and the Radiologi-

cal Society of North America, Palmer House, Chicago, Ill., Sept. 24-29, 1944.

### AMERICAN RADIUM SOCIETY

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*Representatives on American Board of Radiology:* Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

*Twenty-eighth Annual Meeting:* 1944, to be announced.

# EDITORIALS

## THE PROBLEM OF CASTRATION IN MAMMARY CANCER

IN A former issue of this JOURNAL<sup>1</sup> the estrogenic theory of mammary carcinoma was expounded and the implications of such a theory on clinical radiotherapeutic considerations discussed. At that time the question was raised as to whether or not the routine castration of every patient afflicted with mammary carcinoma might not help improve the results over a long period of time through destruction of the estrogen producing source. The clinical and experimental material available, however, appeared contradictory and no tangible conclusions could be reached.

Since then, progress has been more swift, and interest, especially in the various groups of hormonal cancers, has become much keener. It, therefore, may not prove altogether futile to try to review the subject in the light of the newest contributions.

A connection between mammary cancer and sex function was suspected from the earliest days and thus it is not surprising that the first attempts at castration should have been made by surgical approach, before radiation therapy even existed.

Schinzinger,<sup>2</sup> as far back as 1889, proposed the surgical removal of the ovaries in young women with carcinoma of the breast, believing that the induction of artificial menopause would slow down the progress of the cancer.

Beatson,<sup>3</sup> in 1896, reported favorable results by a similar procedure in illustrative

cases of inoperable mammary carcinoma. He noted in a number of instances shrinkage of the primary carcinoma as well as regression of the cutaneous and lymphatic metastases. On the basis of histologic studies of such cases, he made the definite statement that "the surgical removal of the tubes and ovaries has effect on the local proliferation of epithelium which occurs in cancer of the mamma, and helps on the tendency cancer naturally has to fatty degeneration." Boyd,<sup>4</sup> Thomson,<sup>5</sup> Lett<sup>6</sup> and Torek<sup>7</sup> reported additional series of cases with the favorable results varying between 23 and 41 per cent. The effect always appeared more impressive in the premenopausal period. Interest in the surgical procedure then gradually waned until very recently. In April, 1944, a notable contribution was made by Horsley<sup>8</sup> who published his results in a series of 25 cases which had been oöphorectomized since November, 1937. What seems to have induced Horsley to adopt surgical castration routinely is the disappointing experience he has had with radical mastectomy in cancer of the breast in young women. At first he did bilateral oöphorectomy with radical operation only on patients under forty years of age, but

with illustrative cases. *Lancet*, 1896, 2, 104-107; 162-165.

Beatson, G. T. The treatment of inoperable carcinoma of the female mamma. *Glasgow Med. J.*, 1911, 76, 81-87.

<sup>4</sup> Boyd, S. On oöphorectomy in cancer of the breast. *Brit. M. J.*, 1900, 2, 1161-1167.

<sup>5</sup> Thomson, A. Analysis of cases in which oöphorectomy was performed for inoperable carcinoma of the breast. *Brit. M. J.*, 1902, 2, 1538-1541.

<sup>6</sup> Lett, H. An analysis of 99 cases of inoperable carcinoma of the breast treated by oöphorectomy. *Lancet*, 1905, 1, 227-228.

<sup>7</sup> Torek, F. Disappearance of recurrent mammary carcinoma after removal of the ovaries. *Ann. Surg.*, 1914, 60, 476-477.

<sup>8</sup> Horsley, J. S. Bilateral oöphorectomy with radical operation for cancer of the breast. *Surgery*, April, 1944, 15, 590-601.

<sup>1</sup> Leucutia, T. Irradiation and the estrogenic theory of mammary carcinoma. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1941, 45, 923-925.

<sup>2</sup> Schinzinger, Das Karzinom der Mamma. *München. med. Wchschr.*, 1905, 52, 1724-1725.

<sup>3</sup> Beatson, G. T. On the treatment of inoperable cases of carcinoma of the mamma; suggestions for a new method of treatment



later the method was extended to all patients in the premenopausal stage. It is Horsley's contention that complete abolition of all ovarian function cannot be brought about by roentgen irradiation, however exact the technique of administration may be. Surprisingly, a study of the final outcome in his cases reveals that only 2 recurrences developed in the entire series although 19 cases were operated on from fourteen months to six years previously. One recurrence was noted in a patient with bilateral mammary cancer, who doubtless had internal metastases at the time of operation, notwithstanding the fact that they could not be demonstrated then, and the other was in a patient with mucoid cancer.

Castration by means of roentgen rays (and radium), although introduced considerably later, has created an interest which far surpasses that of the surgical approach. A very voluminous literature has sprung up dealing with all possible phases of the procedure. In an important article, Ahlbom,<sup>9</sup> by summarizing the investigations up to 1930, expressed the opinion that routine roentgen castration does not lead to prolongation of life in the average case of cancer of the breast nor does it diminish the incidence of metastatic extension. Moreover, the climacteric symptoms induced prematurely often constitute an unnecessary burden. This viewpoint continued to dominate the literature and was endorsed only very recently by Ritvo and Peterson<sup>10</sup> who make the categorical statement that in the light of present day knowledge routine ovarian sterilization of all patients with cancer of the breast in the premenopausal age period is inadvisable. A statistical survey made of a rather large number of cases treated at Harper Hospital in Detroit<sup>11</sup> revealed that if the final

results were classified according to age incidence, the poorest results were obtained in the group between fifty and fifty-nine years, that is immediately after the onset of the normal menopause. A priori, this observation also seems to support the opinion that routine roentgen sterilization of every case of mammary cancer constitutes a futile and valueless effort.

Yet there is one phase in connection with the roentgen suppression of ovarian function in cancer of the breast which contradicts such a standpoint. It has been repeatedly observed that osseous metastases secondary to cancer of the breast often regress or disappear completely following roentgen sterilization. Ritvo and Peterson<sup>10</sup> after a survey of the literature, believe that one-third or more of the patients so treated may be expected to show improvement and prolongation of their period of usefulness although they are not certain that a prolongation of life is obtained at the same time. Likewise it is not clear—despite some very striking reports in the literature—whether local recurrences and visceral metastases present a similar degree of response attributable to roentgen treatment of the ovaries.

A consideration of the results of pertinent animal experiments may perhaps furnish one or two leads. In 1927, Cori<sup>12</sup> carried out a series of very illuminating investigations on the influence of bilateral oöphorectomy on the spontaneous occurrence of mammary carcinoma in mice. For this purpose he used pure strains which were developed by March and in which after eight inbred generations over a period of five years the cancer rate and cancer age varied but little. The non-breeding females which were used for control exhibited a cancer incidence of 78.5 per cent and an age of maximum cancer rate of fourteen to fifteen months. The experi-

<sup>9</sup> Ahlbom, H. Castration by roentgen rays as an auxiliary treatment in radiotherapy of cancer mammae at Radiumhemmet, Stockholm. *Acta radiol.*, 1930, 11, 614-633.

<sup>10</sup> Ritvo, M., and Peterson, O. S., Jr. Regression of bone metastases from breast cancer after ovarian sterilization. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 51, 220-229.

<sup>11</sup> Evans, W. A., and Leucutia, T. Deep roentgen-ray therapy of mammary carcinoma. III. Fifteen year results in a formerly published group and a statistical analysis of 1,200 cases treated

between 1922 and 1937. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1939, 42, 866-882.

<sup>12</sup> Cori, C. F. Influence of ovariectomy on spontaneous occurrence of mammary carcinomas in mice. *J. Exper. Med.*, 1927, 45, 983-991.

ments were divided into three groups. In one, bilateral oöphorectomy was performed at the age of fifteen to twenty-two days, immediately after weaning, that is before sexual maturity developed; in another, at the age of two to six months of life, that is after three to twenty estrus cycles had taken place, and in a third at the age of six to seven months, that is after forty estrus cycles occurred (the average mouse has seventy to eighty estrus cycles during life, each of from four to six days' duration.) It was found that in Group 1 not one single case of cancer developed; in Group 2, the incidence was reduced to 10 per cent and the cancer age was raised to from eighteen and one-half to twenty-one months, and in Group 3 there was no influence. From this the conclusion was drawn that "spontaneous mammary carcinoma of the mouse is due to a hereditary organ disposition, which remains latent in the absence of ovarian function but which becomes manifest when a certain amount of ovarian hormone, corresponding to 5 to 30 estrus cycles, has acted on the breast tissue."

Of further interest in this respect are the more recent experiments of Fekete, Woolley and Little.<sup>13</sup> These investigators observed that oöphorectomy at birth in a certain strain of mice is followed by a gradual recovery from the castrate state and the development of mammary cancer as if no castration had been done. The particular strain studied was the dba strain of the Jackson Laboratory which has about 50 per cent breast tumor incidence in virgin females. Oöphorectomy was performed on the first post partum day and the animals killed at different ages. Minute histologic studies revealed that the vagina, uterus and breast tissues showed a stage of development which they presumably can attain only under the influence of estrogenic hormones. In 37 of 75 animals examined, mammary tumors (3 adenomas and 34 carcinomas) developed between the ages of

fourteen and twenty-eight months. The cortex of the adrenal gland consistently presented nodular hyperplasia, the morphologic appearance of which was similar to the lutein-like cells of the ovaries. It was suggested, therefore, that the adrenal cortex had taken over the function of the removed ovaries and since in no case was there evidence of regeneration of the ovarian tissue that the hypertrophic nodules of the adrenal cortex had become the new foci of estrogenic production. Other noteworthy points were that the marked nodular hyperplasia of the adrenal cortex appeared only in the later periods of the life of the animal and that the changes manifested themselves more rapidly after oöphorectomy at a more advanced age.

It is often difficult and hazardous to apply the results of animal experiments to the human. Fekete, Woolley and Little were very careful to point out that not even all strains of mice show the same behavior. Nevertheless, by carefully weighing the clinical and experimental evidence available up to the present, one may formulate the following conclusions concerning the value of castration in the treatment of mammary cancer.

(1) In the presence of osseous metastases, roentgen castration is beneficial in at least one-third of the cases. Therefore, its use in association with other established procedures, such as intravenous colloidal lead therapy, generalized irradiation of the affected areas, and so forth, is recommended. After a latent period of varying duration, however, recurrences or new metastases develop and the further progress of the cancer can be influenced but little. This may be explained on the assumption that through adjustment, other organs, as for example the adrenal cortex, have taken over the estrogen producing function or that the cancer, after breaking down all barriers of resistance, has simply gotten out of control. Perhaps additional information will be gained on this from a study of the remarkable response of osseous metastases which is now being observed with in-

<sup>13</sup> Fekete, Elizabeth, Woolley, George, and Little, C. C. Histological changes following ovariectomy in mice. *J. Exper. Med.*, 1941, 74, 1-8.

creasing frequency in mammary cancer of the male following bilateral orchidectomy.

(2) In local recurrences and generalized visceral metastases, roentgen castration is of questionable value, although sporadic favorable results are described in the literature.

(3) In the operable group of mammary cancer, radical surgery associated with intensive local and regional irradiation seems to offer the best combination of treatment for the final success.

Surgical castration performed at the time of radical mastectomy has given, in the hands of Horsley,<sup>8</sup> very impressive results. It appears that the incidence of local recurrences and metastases is being reduced in the premenopausal age. However, a much larger series of cases is required before this conclusion can be made final. Also, there is not sufficient evidence as yet that surgical castration can replace local and regional irradiation as an adjunct to radical mastectomy. In the animal experiments, surgical castration to be of absolute value had to be performed before the onset of sexual maturity. If it was performed during a period corresponding to less than one-

third of sexual life there still was a decrease in the incidence of mammary cancer, but after that there was no effect. At still later periods, the rather rapid readjustment in the balance of the endocrine system entered into play.

Routine roentgen castration in association with the above stated local and regional methods, to forestall or retard the appearance of distant metastases is for the time being considered inadvisable. Cori<sup>12</sup> in his experiments found that in almost 10 per cent of the oöphorectomized mice a remarkable regeneration of the ovarian tissue developed during later life. It is probable that following roentgen castration, as used currently, a similar regeneration occurs more quickly and in a more integral manner. For this reason a durable effect over a long period of time does not appear certain. It is conceivable, however, that in those instances in which osseous metastases are already in the process of formation, though undemonstrable by physical means, roentgen castration may have a beneficial effect in retarding their actual appearance.

T. LEUCUTIA





*Bolivar Studios, Inc.*

JOHN THOMAS MURPHY  
1885-1944

DR. JOHN T. MURPHY died on June 15 in his native city of Toledo, in St. Vincent's Hospital, where he had been Director of the Department of Radiology since 1919. His death was cardiovascular, and he had been incapacitated only a few months.

Dr. Murphy was born in Toledo, Ohio on August 15, 1885. He received the degree of M. D. from the Toledo Medical College in 1906. His active participation in radiology dates back to 1915 and was begun at Cook County Hospital in Chicago. He became a member of the American Roent-

gen Ray Society in 1918 and was its President in 1933; he served as its Secretary from 1928 to 1931. Those who attended recent meetings of the Society will look back with pleasure and profit on the courses he gave on the roentgen diagnosis and the clinical course of bone tumors. His exhibit in this field jointly with his associate Dr. Clarence E. Hufford won a silver plaque at the Fifth International Congress of Radiology in Chicago in 1937.

In addition to the American Roentgen Ray Society, Dr. Murphy numbered among his memberships the following: Academy of Medicine of Toledo and Lucas County, of which he was a past President; Detroit Roentgen Ray and Radium Society, Ohio State Roentgen Society, American Medical Association, serving as Secretary of its Section on Radiology for a number of years, a fellow of the American College of Radiology and its President in 1935, a fellow of the American College of Physicians, American Radium Society, Radiological Society of North America, Diplomate of the American Board of Radiology, Knights of Columbus, Fourth Degree. He was also an honorary member of the Toledo Notre Dame Society.

Dr. Murphy was married to Miss Leila Schuller in 1907; their daughter is now Mrs. Helen Carson of Toledo. Several years after the death of his first wife he was married to Miss Pauline Feil in 1916. Their children are Mrs. Jeanne Reynolds, Lieutenant John T. Murphy, and Patricia Murphy.

Dr. Murphy was a man of wide extracurricular interests. He was one of Toledo's pioneer airplane pilots. Long before pilots were licensed he flew his own plane and became a friend of many early fliers. He never lost his interest in aviation and he was one of the sponsors of the Civil Air Reserve in Toledo. He was a member of the track team in college and he always maintained his interest in athletics. He was a member of the American Amateur Athletic Association and President of the Toledo Figure Skating Club. In addition to being a fine skater, Dr. Murphy also excelled in golf. He was much interested in photography and was awarded many prizes for his unusual impressionistic photographic views.

Dr. Murphy was a friendly man and was a loyal friend. His influence and wise counsel were of much benefit in the many activities to which he gave so much of himself and his time. Whatever he undertook he entered into wholeheartedly. During all of his years as a member of the American Roentgen Ray Society he took an active part in its affairs and he had no small part in bringing radiology to the position of importance which it occupies in medicine today. He was a faithful attendant at the numerous medical meetings to which he belonged and he will be greatly missed both at the scientific discussions and the various social gatherings at which his presence was always welcome.

RAMSAY SPILLMAN

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# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer.*

## MEETINGS OF ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary*, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Joint Meeting of American Roentgen Ray Society and Radiological Society of North America, Palmer House, Chicago, Ill., Sept. 24-29, 1944.

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary*, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary*, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio.

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary*, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Joint Meeting of American Roentgen Ray Society and Radiological Society of North America, Palmer House, Chicago, Ill., Sept. 24-29, 1944.

#### RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

*Secretary*, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

#### SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

*Secretary*, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.

#### RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

*Secretary*, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

#### SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

*Secretary*, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

#### RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION

*Secretary*, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

#### RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

*Secretary*, Dr. Roy G. Giles, Temple, Texas.

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary*, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

#### CHICAGO ROENTGEN SOCIETY

*Secretary*, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary*, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 p.m. at Allerton Hotel on fourth Monday each month, October to April, inclusive.

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary*, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 p.m.

#### DENVER RADIOLOGICAL CLUB

*Secretary*, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary*, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

#### FLORIDA RADIOLOGICAL SOCIETY

*Acting Secretary*, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary*, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

#### INDIANA ROENTGEN SOCIETY

*Secretary*, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meeting held the second Sunday in May annually.

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary*, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 p.m.

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary*, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

#### NEBRASKA RADIOLOGICAL SOCIETY

*Secretary*, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 p.m. at either Omaha or Lincoln.

#### NEW ENGLAND ROENTGEN RAY SOCIETY

*Secretary*, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

#### RADIOLOGICAL SOCIETY OF NEW JERSEY

*Secretary*, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

#### NEW YORK ROENTGEN SOCIETY

*Secretary*, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 p.m.

#### NORTH CAROLINA ROENTGEN RAY SOCIETY

*Secretary*, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

\* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

**NORTH DAKOTA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

**CENTRAL NEW YORK ROENTGEN RAY SOCIETY**

*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

**OHIO RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. E. McCarthy, 707 Race St., Cincinnati. Meets at time and place of annual meeting of Ohio State Medical Association.

**PACIFIC ROENTGEN SOCIETY**

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

**PENNSYLVANIA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. L. E. Wurster, 416 Pine St., Williamsport.

**PHILADELPHIA ROENTGEN RAY SOCIETY**

*Secretary*, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

**PITTSBURGH ROENTGEN SOCIETY**

*Secretary*, Dr. R. G. Alley, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

**ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.**

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

**ROCKY MOUNTAIN RADIOLOGICAL SOCIETY**

*Secretary*, Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

**ST. LOUIS SOCIETY OF RADIOLOGISTS**

*Secretary*, Dr. E. W. Spinzig, 2646 Potomac, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

**SAN DIEGO ROENTGEN SOCIETY**

*Secretary*, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

**SAN FRANCISCO RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Martha Mottram, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Toland Hall, University of California Hospital, second six months at Lane Hall, Stanford University Hospital.

**SHREVEPORT RADIOLOGICAL CLUB**

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

**SOUTH CAROLINA X-RAY SOCIETY**

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

**TENNESSEE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

**TEXAS RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, January 17, 1945.

**UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING**

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

**UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE**

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

**VIRGINIA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

**WASHINGTON STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

**X-RAY STUDY CLUB OF SAN FRANCISCO**

*Secretary*, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

**CUBA****SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA**

*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

**BRITISH EMPIRE****BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY**

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

**SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)**

Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

**FACULTY OF RADIOLOGISTS**

*Secretary*, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

**SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS**

*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

**RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION**

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

**CANADIAN ASSOCIATION OF RADIOLOGISTS**

*Secretary*, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton, Alberta.

**SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION**

*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

**RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION**

*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

**SOUTH AMERICA****SOCIEDAD ARGENTINA DE RADIOLOGIA**

*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

**CONTINENTAL EUROPE****SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA**

*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

**SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)**

*Secretary* for French language, Dr. A. Grosjean La Chaux de Fonds.

*Secretary* for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

**SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE**

*Secretary*, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

**ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.**

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

**LENINGRAD ROENTGEN RAY SOCIETY**

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

**MOSCOW ROENTGEN RAY SOCIETY**

*Secretaries*, Drs. L. L. Holst, A. W. Ssamygina and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

**SCANDINAVIAN ROENTGEN SOCIETIES**

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.



## TUBERCULOSIS CASE-FINDING PROGRAM

TO THE EDITOR:

The editorial in the June, 1944, issue of the *AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY* entitled "An evaluation of the roentgen methods used in mass chest surveys" is of particular interest to us because of an effective tuberculosis case-finding program in operation at the Home Office of the Metropolitan Life Insurance Company in New York City since 1927. Following its inception the incidence of pulmonary tuberculosis in our group of 13,000 to 14,000 Home Office employees was reduced quickly to a point where it was no longer a major problem and has been held there continuously. It is therefore a pleasure to affirm as facts many of the things which are assumed in the editorial to be true.

For many years prior to 1927 we were accustomed to send from the Home Office in New York City to cure at our Sanatorium at Mount McGregor an average of four cases of active pulmonary tuberculosis for each thousand Home Office employees. Most of them, 60 per cent to be exact, were in the advanced stages at the time of diagnosis. The fact that many cases came to light shortly after a physical examination reported as "normal" demonstrated clearly that such an examination was inadequate. It was with the hope that we could detect at least most of the advanced cases that we began in 1927 a routine fluoroscopic examination of the chest of all *applicants for employment* at the Home Office, and at each annual examination of all *Home Office employees*. The purpose of this fluoroscopic examination was not to diagnose tuberculosis, but rather to select the persons from an average healthy working group who needed further study, which included a 14 by 17 inch roentgenogram.

As soon as the program was fairly under way, our tuberculosis problem began to come under control. The incidence of tuberculosis among our Home Office employees which had been annually *four per thousand* prior to 1927 soon became *one per thousand*, and for many years has been *less than one per thousand* per year. Perhaps it is even more important that for the past ten years the *stage* of tuberculosis among new cases has been *73 per cent minimal* as contrasted to a former *60 per cent advanced*.

If this change had occurred simultaneously with a decreasing incidence of tuberculosis among applicants for employment, it could not properly be called a "control program." But the fact is that the incidence of chest lesions typical of pulmonary tuberculosis among applicants for employment has been relatively stable since 1927, has shown no real or consistent decrease, and does not differ materially from the incidence reported among inductees for the Armed Services. Incidentally, if a suspicious lesion is found in an applicant for employment, we make every effort to see that the case is followed to a conclusion, either by the family physician or at a clinic or hospital, and we have found practically no obstruction or lack of cooperation in our efforts.

It is interesting that the roentgenologic method rated in the editorial as least effective, namely, routine roentgenoscopy, supplemented with 14 by 17 inch roentgenogram when indicated, has brought about the result described above and in an economical manner. The most important decision to be made in any tuberculosis case-finding program, regardless of the method to be used, is *to begin!*

H. H. FELLOWS, M.D.

*Assistant Medical Director*

Metropolitan Life Insurance Company  
New York, New York.



## BOOK REVIEWS

*Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.*

**THE ARTHROPATHIES: A HANDBOOK OF ROENTGEN DIAGNOSIS.** By Alfred A. de Lorimier, A.B., M.A., M.D., Colonel, Medical Corps, United States Army; Commandant, The Army School of Roentgenology, Memphis, Tenn.; Formerly Director, Department of Roentgenology, Army Medical School, Washington, D. C. Cloth. Price \$5.50. Pp. 319, with 678 illustrations. Chicago: Year Book Publishers, Inc., 1943.

This volume is one of a series of handbooks on roentgenographic diagnosis. Webster's definition of a handbook is "a book or manual, usually of small size." The publisher has conformed to this definition by compiling a book of small size with small but legible print, which is a relief from the usual, more bulky volume on roentgenographic interpretation. The author has contributed to the handbook effect by very concise descriptions using the least number of words possible. Each disease is described by headings: synonyms, roentgenographic criteria, corroborative roentgenographic criteria, incidence, history, physical findings, clinical course and bibliography. The illustrations consisting of diagrams, roentgenograms and a few pathological specimens, number 678. These are compactly placed, two to four on a page, and are conveniently arranged in the text to illustrate the specific disease. The diseases are grouped according to their etiology. The result is a handy volume.

Colonel de Lorimier has had much experience in the teaching of roentgenology. The handbook is a compilation of lectures given him since 1938 at the Army Medical School and the Army School of Roentgenology. He states in the preface that the material is presented in the form followed by his teaching: "Instruction has been graphic, presenting first an orientation of the subject; then a catalogue by films or lantern slides of essential diagnostic criteria, and finally corroborative clinical and laboratory aspects." Under each heading the essentials for the diagnosis of the condition can be readily grasped. The illustrations have the salient roentgen changes marked with arrows. Occasionally the multiplicity of arrows tends

to obscure the bone detail of the roentgenograms.

The book is certain to be useful and valuable to the student and roentgenologist for ready reference and essential diagnostic criteria. The bibliography is ample.

RALPH S. BROMER

**THE MODERN MANAGEMENT OF COLITIS.** By J. Arnold Bargen, M.D., M.S., F.A.C.P., Chief of the Section on Intestinal Diseases, Division of Medicine, Mayo Clinic; Associate Professor of Medicine, Mayo Foundation, Rochester, Minnesota; Secretary, American Gastroenterological Association; Vice Chairman, Section on Gastroenterology and Proctology, American Medical Association. Cloth. Price, \$7.00. Pp. 322, with 148 illustrations. Springfield, Illinois: Charles C Thomas, 1943.

This monograph is devoted, as the author states in his preface, to a narration of his own observations and experiments based on the rich clinical material of the Mayo Clinic. He has made no attempt to review the voluminous literature on the subject but he has included 85 references in the bibliography. Theory and tradition about any intestinal ailment have been challenged by direct experimental attack and the results of such an attack have been set down in simple fashion. As a result, the book is pleasing in style, easily read and assimilated and well illustrated with reproductions of pathological specimens, roentgenograms, charts and tables. The part played by roentgenology in the diagnosis is well covered. It is now possible to distinguish accurately real inflammatory disease from functional colonic disorders. Bargen bases his classification of the types of ulcerative colitis on present day knowledge of their causation.

The list of chapters indicates the comprehensive scope of this monograph. They include: The Irritable Colon; Types of Ulcerative Colitis; Thrombo-Ulcerative Colitis: Streptococcal (Type 1); Regional (Segmental) Ulcerative Colitis (Type 2); Chronic Ulcerative Colitis (Type 3); Tuberculous Ulcerative Colitis

(Type 4); Amebic Ulcerative Colitis (Type 5); Colitis (Type 6); Its Relation to Food and Vitamin Deficiency; Ulcerative Colitis (Type 7): Due to the Virus of Venereal Lymphogranuloma; Allergic Colitis (Type 8); Chronic Ulcerative Colitis (Type 9): A Late Phase of Bacillary Dysentery; and a final chapter on Conditions to be Distinguished from Colitis.

This volume should be included among the reference books of the roentgenologist as an aid in diagnosis and more efficient collaboration with the gastroenterologist and the internist. The chapter on the irritable colon is to be especially commended.

RALPH S. BROMER

A HUNDRED YEARS OF MEDICINE. By C. D. Haagensen and Wyndham E. B. Lloyd. Cloth. Price, \$3.75. Pp. 444, with several illustrations. New York: Sheridan House, 1943.

This book deals in an effective and readable manner with the story of the development of our knowledge of various epoch making contributions to medicine and the men who made them. Although it is written in simple terms and is primarily for the layman, it is an excellent presentation of the facts concerning the most important advances in clinical medicine and the medical sciences. Physicians and medical students, as well as non-medical persons, could well read such a book with profit. Unquestionably it meets a definite need. It is not an all-inclusive encyclopedic volume, but it does appear to be an authoritative narration dealing with the important discoveries in medicine and surgery with which all educated persons should be familiar.

It is astonishing to the reviewer that intelligent lay persons, physicians, and medical students are often completely devoid of even the slightest curiosity concerning the historic development of our knowledge of medicine. Constantly, in the practice of medicine, important procedures are employed which have interesting stories behind them. A knowledge of these forms the basis for a scholarly grounding in the subject. But how many who may be reading this book review have any idea of when the important discovery of the x-ray by Wilhelm Konrad Roentgen occurred, or how he came upon this momentous dis-

covery? Or, for example, when was the first transfusion with human blood accomplished? Or, to consider more recent events, when did Gerhard Domagk introduce the sulfonamide preparations, and what led to the discovery of the earliest forerunner of the drugs which so mightily combat certain infections? These and many other interesting questions are answered in this worthwhile publication. The sole approach to a complete understanding of any topic is the historical one. It is only by knowing and correlating every step of the development of our knowledge that we can have a true conception of any subject.

This book is not concerned entirely with the last hundred years of medicine which the title would have us believe, for the first division of fifty-five pages is devoted to the historic aspects of medicine up to one hundred years ago. Furthermore, in the description of the development of our knowledge, the authors go back very properly to the beginnings which in some instances were prior to 1844. The three other divisions of the book are devoted respectively to "Medical Science during the last 100 years, Surgery during the last 100 years, and the New Social Aspects of Medicine."

The historic story of medicine is attractively written, and hence may be read with interest and pleasure by the medical man and the layman. It is comprehensive in its scope for it appears to have included all of the more important advances in medicine and surgery. The descriptions seem to be accurate with minor exceptions. Some of the more modern developments are included such as the introduction of the sulfonamide drugs, but no reference is made to the remarkable effect of penicillin despite the fact that it was first described by Alexander Fleming in 1929, and its clinical worth was recognized in 1940. Some minor errors or omissions were noted by the reviewer in a few subjects in which he has special interest. For example, why was not the name of Richard Lower, Professor of Physiology at Oxford, mentioned as the one who first gave a blood transfusion from one dog to another? This event which occurred in February, 1665, probably did more than anything else to stimulate interest in human blood transfusions which led ultimately to the perfection of the method.

CYRUS C. STURGIS

## DEPARTMENT OF TECHNIQUE

*Department Editor:* ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.  
Charleston, S. C.

## THE ADVANTAGE OF INCREASED FILTRATION

By WILLIAM S. ALTMAN, M.D.  
QUINCY, MASSACHUSETTS

IT IS well known that, by the use of increased filtration, soft tissue detail and contrast are accentuated and there is a resultant added latitude. The addition of 1 to 3 millimeters (depending on the thick-

tissue and helps to prevent the obliteration of the soft tissues of the abdominal wall (Fig. 1).

The second type of examination in which added filtration is of value is in the lateral view of the lumbosacral spine. Here again 4 mm. of aluminum is used as a filter. It will be noted that the vertebral bodies are



FIG. 1



FIG. 2

ness of the part) will suffice. This additional filtration necessitates a 10 to 20 per cent increase in exposure.

The procedure is of distinct value particularly in two types of examinations.

The first is in the visualization of the placenta in the lateral view of the abdomen. The use of 4 mm. of aluminum filtration brings out in better detail the placental

clearly demonstrated, the laminae of the fifth lumbar vertebra are well outlined and the spinous processes are not obliterated (Fig. 2).

32 Spéar St.,  
Quincy, Mass.

# A PRINTING FRAME FOR MAKING COPIES OF ROENTGENOGRAMS

By WILLIAM S. ALTMAN, M.D.

QUINCY, MASSACHUSETTS

ON OLD or discarded cassette can be transformed into a printing frame by substituting glass for the bakelite (Fig. 1). An aluminum cassette may also be used if the aluminum front is cut out and replaced by glass.

The same frame can be used for smaller size films simply by making mats from the paper of a 14×17 inch film and cutting apertures to the size desired.

32 Spear St.,  
Quincy, Mass.

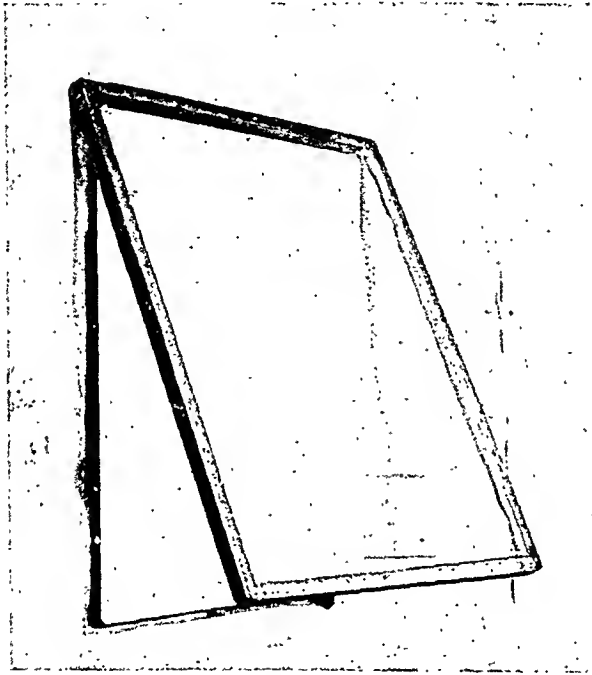


FIG. 1



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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN DIAGNOSIS

### SKELETAL SYSTEM

PALMQUIST, WALTER N. Roentgen analysis of upper cervical spine injuries. *Radiology*, Jan., 1943, 40, 49-55.

This paper presents a method of analysis of upper cervical roentgenograms with the aid of index lines. First there must be a clear accurate lateral film in making which the roentgen-ray beam should parallel, as nearly as possible, a line through the two ear openings. The analysis can be practiced directly on the film but it is better to make a tracing leaving the film unchanged.

The first guide line is a horizontal one passing medially through the body of the atlas. Three parallel lines are then drawn perpendicular to this one, passing respectively through the point where the first line intersects the anterior surface of the upper boundary of the odontoid, the point where it intersects the anterior surface of the atlas tubercle and the point where it intersects the mandible. A fifth line is drawn along the anterior edge of the body of the axis and a sixth through the lower anterior corner of the body of the axis and a sixth through the lower anterior corner of the body of the axis. Three additional guide lines may be helpful in anticipating possible later angulation dislocations. One is drawn as nearly as possible tangent to the anterior surface of any vertebra below the axis, one tangent to the upper surface of the fifth cervical vertebra and one tangent to the lower surface of the fourth cervical. Diagrams are given showing the application of the method.

These guide lines are of maximum significance only when the roentgenogram is made with the patient in the normal erect position. Their value is greatly impaired if the head is in hyperextension.—*Audrey G. Morgan*.

ENGLANDER, O. Non-traumatic occipito-atlanto-axial dislocation. *Brit. J. Radiol.*, Dec., 1942, 15, 341-345.

In addition to fracture dislocation three types

of non-traumatic occipito-atlanto-axial dislocation may occur: (1) forward dislocation of the atlas on the axis; (2) atlanto-axial rotation dislocation; (3) occipito-atlantoid dislocation. These dislocations may be caused by any inflammation in the upper part of the neck, such as acute tonsillitis, diseases such as syphilis or tuberculosis that destroy structures that enter into the atlantoid joints, unguarded sudden movements of the head or other trauma. Any of these dislocations may be manifested clinically by torticollis. In the roentgenogram the transverse process of the atlas can be palpated behind the mastoid in occipito-atlantoid dislocation. Normally it is palpated in front of the mastoid. The recognition of such a dislocation is important because it is more difficult to reduce than atlanto-axial dislocation. The only view in which occipito-atlantoid dislocation can be recognized in the submento-vertical or vertico-submental. One of the objects of this paper is to show the importance of this view. A case of occipito-atlanto-axial dislocation is described in a girl seven years of age. It followed acute tonsillitis and bilateral suppurative submaxillary lymphadenitis. In addition to this view the lateral and anteroposterior views are of value. A roentgenogram, tomogram and tracing of a tomogram of the case are given. Roentgenograms of the normal upper cervical spine are also given for comparison.—*Audrey G. Morgan*.

GRAY, E. D. Calcification and ossification of spinal tumours. *Brit. J. Radiol.*, Dec., 1942, 15, 365-369.

Spinal tumors are sometimes directly visible on plain roentgenograms because there are areas of calcification or ossification within them. This occurs in perhaps not more than 10 per cent of cases of spinal tumor and examination is rarely made for them because of the difficulty of roentgenography of the spinal canal. Tomography has proved of considerable value in this field and will doubtless become increasingly valuable in the future.

Three such cases have been seen in the last three years at the Manchester Royal Infirmary. They are described and illustrated with roent-



genograms. Two of them were meningiomas, one of the psammomatous and the other of the osteoblastic type. The other was an intramedullary tumor, probably a hemangioblastoma. All of these tumors were in the dorsal region, as are the majority of these calcified or ossified tumors. The great majority of them are also meningiomas, particularly of the psammomatous type. The image seen in the roentgenogram is that of an olive-shaped opacity in the spinal canal. Generally there are no associated indirect signs, such as thinning of the pedicles or enlargement of the foramina.—*Audrey G. Morgan.*

PEIRCE, CARLETON B., and EAGLESHAM, DOUGLAS C. Traumatic lipohemarthrosis of the knee. *Radiology*, Dec., 1942, 39, 655-662.

The authors describe 7 cases of fracture of the tibia in one of which the fracture was bilateral and in which roentgen examination showed layering of the joint fluid, indicating the presence of blood and fat. They call attention to the presence of a subpatellar deposit of fat and similar smaller deposits around the base of the cruciate ligaments. None of these lies in the synovial space and severe injury is required to produce extravasation of fat from these deposits into the joint space. On the other hand, hemorrhagic effusion may occur without severe injury.

They suggest examination in the supine position with a horizontal lateral projection as a method which permits of the demonstration of this layering and spares the patient movement as far as possible. In one of the cases aspiration was done and the presence of fat in the fluid demonstrated. They suggest the name of traumatic lipo-hemarthrosis for this condition.

In the discussion Dr. Harbin said that while he had aspirated blood from many injured knees he had never found fat present in the fluid. He regretted that the authors of this article had not performed aspiration and demonstrated the presence of fat in more of their cases. The layering might be due to clotting of the blood with separation of the blood into corpuscles and serum, the layers being of different densities.—*Audrey G. Morgan.*

STEINER, HOWARD A. Roentgenological manifestations and clinical symptoms of rib abnormalities. *Radiology*, Feb., 1943, 40, 175-178.

Among 38,105 roentgenograms showing the

ribs made at the Department of Radiology of the University of Colorado Medical School 59 showed anomalies of the ribs (0.15 per cent). There were 19 cases of cervical ribs and 17 of lumbar ribs, making up more than half of the total number. The others were bipartition or forking of the anterior ends of the ribs, synostosis or bony union of adjoining ribs, tile-roof ribs, or imbrication, rudimentary ribs and a few other unclassified deformities. The patients ranged from five to seventy-eight years of age; 30 were males and 29 females.

In 10 of the cases of cervical rib and 12 of the other cases there was a very definite correlation between the anomaly of the ribs and pain. In one of the cases of bipartition, 2 of synostosis and 3 of the 4 of tile-roof ribs there was tuberculosis or pneumonia, evidently due to limitation of space in the thorax by the anomaly. In 26 of the cases no relationship could be found between the rib anomalies and any clinical symptoms. In 17 of these cases the abnormality was of such a nature that no anatomical or physiological disturbance was to be expected.—*Audrey G. Morgan.*

TENNENT, WILLIAM. Bi-lateral fractures of the clavicles. *Brit. J. Radiol.*, July, 1942, 15, 211.

Fracture of one clavicle is one of the commonest accidents seen in roentgenography but fracture of both clavicles is very rare. A case is described in a man of forty-nine who was struck on one shoulder by a truck and hurled violently against an approaching streetcar, striking on the other shoulder. The roentgenogram showing fracture of both clavicles is shown. In these cases the lungs are almost always affected and breathing is very difficult when the patient is lying down. In this case the patient had to lie on a stretcher for an hour before admission to the hospital and he was definitely cyanotic when admitted.—*Audrey G. Morgan.*

#### BLOOD AND LYMPH SYSTEM

BRAKELEY, ELIZABETH. Leukemia resembling chloroma. *Am. J. Dis. Child.*, Oct., 1942, 64, 689-696.

The author reports a case of lymphatic leukemia with the clinical appearance of chloroma in a boy, aged two and a half. The patient had an enlarged head, with wide separation of the sutures, pronounced exophthalmos and enlarged lymph nodes, especially of the neck and

mediastinum, but no metastases to bone. The predominating white cell was a lymphoblast, and no myelocytes or myeloblasts were seen.

The roentgenogram of the skull showed widening of the sutures and the absence of metastases. The roentgenographic examination of the chest before roentgen therapy showed pronounced widening of the mediastinal shadow and after therapy showed marked reduction in the width of the mediastinum.—*R. S. Bromer.*

HODES, PHILIP J., FORRESTER, J. S., and LOCKWOOD, J. S. [Lymphosarcoma]. *Radiology*, Feb., 1943, 40, 188-190.

This clinico-pathological conference was based on the case of a Jewish woman, aged forty-three, admitted to hospital in August, 1941, complaining of pain in the right cheek and swelling of the right submaxillary and cervical lymph nodes which had existed for eight months, during which time anorexia and vomiting had developed and she had lost 30 pounds in weight. Examination showed soft masses in the right cheek, a hard irregular mass in the right breast, one in the axilla and several smaller lumps in the left breast. Masses in the lower abdomen were thought to be attached to the uterus. Laboratory studies, including blood count, were normal. Roentgenograms of the sinuses showed chronic disease of both antra with polypoid changes on the right side. After four weeks' treatment she improved somewhat and was discharged but returned in November, 1941, with a great increase in the size of the abdominal mass, dyspnea and cough. Bilateral salpingo-oophorectomy was performed in December. The patient failed rapidly and died in January, a year after the beginning of symptoms.

In the discussion Dr. Lockwood said this was an unusual case. The patient had a chronic wasting disease with lumps in each breast which suggested carcinoma with wide-spread metastases. But because of the diffuse nature of the disease, its spotty manifestations in widely separated lymph nodes and the soft tissue masses in the cheeks and breasts he concluded it was some type of lymphoblastoma, Hodgkin's disease, sarcoma or leukemia.

The patient was given small doses of roentgen therapy to right cheek, breasts and axilla from October 2 to December 27. The total amount was small, the maximum being 650 r total to the right cheek. This small dosage was

given because it was believed that the tumor was radiosensitive but it is now believed that more vigorous treatment would have been better.

Sections from the first biopsy of an inguinal lymph node suggested leukemia or Hodgkin's disease. On autopsy practically every organ in the body was invaded by tumor and all the lymph nodes were greatly enlarged. Histopathologic examination suggested lymphosarcoma rather than the ordinary type of Hodgkin's disease.

Clinical diagnosis: carcinoma of the breast; uterine fibroid. Dr. Lockwood's diagnosis: lymphoblastoma. Diagnosis from biopsy: probable Hodgkin's disease. Final pathological diagnosis: lymphosarcoma.—*Audrey G. Morgan.*

#### GENERAL

THORNHILL, PATTI S., and THORNHILL, EDWIN H. Boeck's sarcoid with nodular iritis in a child. *Am. J. Dis. Child.*, Aug., 1942, 64, 262-269.

Boeck's sarcoid is a chronic, relatively benign disorder of unknown cause with particular predilection for the lymph nodes, lungs, skin and bones; less frequently there is involvement of the liver, spleen, kidneys, eyes, brain or meninges. A case of ocular involvement is reported in a Negro girl aged nine. The differential diagnosis was: (1) tuberculous iritis, (2) syphilitic iritis and (3) Boeck's sarcoid. By means of physical examination, roentgenograms, intradermal tuberculin and Wassermann tests, repeated examinations of the sputum, inoculations of guinea pigs and histopathological studies of a lymph node, the diagnosis of Boeck's sarcoid was established. Roentgen examination showed bilateral symmetric enlargement of the hilar lymph nodes and a diffuse infiltration of the lungs.

In the authors' survey of the literature it was found that the eye was not a favorite seat of the disease as has been claimed by some. They report the case because of the rarity of ocular lesions in children.—*R. S. Bromer.*

SMYTH, F. S., SOLEY, MAYO H., LISSER, HANS, GOLDMAN, LEON, MILLER, E. R., and LINDSAY, STUART. Medical staff conference on parathyroid gland disease, University of California Medical School Hospital, San Francisco. *Radiology*, Dec., 1942, 39, 715-730.

The case on which this conference was based

was that of a woman of forty-nine who had hypoparathyroid tetany following thyroidectomy. She was placed on a high calcium, low phosphorus diet and treated with dihydrotachysterol, resulting in a decrease of blood phosphorus. On presentation she still showed evidence of old thyroidectomy. The Chvostek and Trousseau reactions were negative, skin dry, eyes somewhat puffy, nails brittle, no visible cataracts and no carpopedal spasm.

Parathyroid disease in children was discussed. Many conditions with demineralization of the bones in children are due to hyperparathyroidism. In such cases it is necessary to preserve a proper calcium-phosphorus balance in the blood serum, and not only the intake of these minerals but also their digestion must be watched. The Aub method of detecting excretion of calcium and phosphorus in urine and stools is valuable in following up these cases. Illustrative cases are described. Secondary parathyroidism associated with profound renal disturbances is more frequent in children than in adults.

In hypoparathyroidism the typical clinical sign is tetany; in hyperparathyroidism one of the typical clinical signs is weakness and hypotonia of the muscles. Among the laboratory findings in hyperparathyroidism are generalized osteoporosis, cysts, tumors and fractures of the bone, blood calcium is increased and blood phosphorus decreased while the opposite condition prevails in hypoparathyroidism.

The treatment of hyperparathyroidism is chiefly surgical to remove excessive parathyroid tissue, while hypoparathyroidism is generally caused by the inadvertent removal of too much parathyroid tissue in thyroidectomy. Treatment of hypoparathyroidism is by intravenous administration of calcium gluconate, oral administration of calcium, giving of thyroid substance, and the administration of vitamin D and dihydrotachysterol. This drug is a photochemical derivative of ergosterol and is commonly called A.T. 10 because it is anti-tetanic preparation No. 10. Its dosage should be controlled by the Sulkowitch test.

Roentgen examination is of little value in hypothyroidism. In hyperthyroidism it shows the typical bone changes, which must be differentiated from those of bone cysts, disseminated osteitis fibrosa, giant cell tumors and enchondroma. Typical roentgenograms are given.

In primary hyperparathyroidism the lesion

that generally causes the high blood calcium and osteoporosis is a solitary chief cell adenoma of one gland. In secondary hyperparathyroidism with severe renal disease (renal rickets) there is hyperplasia of all the glands. Carcinoma of the parathyroid glands is rare and does not generally cause hyperparathyroidism.

In the discussion attention was called to the danger of giving excessive amounts of vitamin D in hyperparathyroidism and rickets and to the importance of using the Sulkowitch test in giving A.T. 10 because of its cumulative action.  
—Audrey G. Morgan.

JACKMAN, JAMES. Roentgen features of scleroderma and acrosclerosis. *Radiology*, Feb., 1943, 40, 163-168.

Four cases of scleroderma and acrosclerosis are reviewed and illustrated with roentgenograms and the literature reviewed. The characteristic roentgen findings of these diseases are calcinosis, changes in the bones and in some cases pulmonary fibrosis and stenosis of the esophagus. Calcinosis is the most striking feature. Calcium is deposited in various parts of the body, particularly parts subjected to pressure. In acrosclerosis the hard plaques can often be felt and ulceration of the distal phalanges generally occurs. Slow progressive absorption of the distal phalanges of the fingers is quite common. An increase in the calcium content of the distal phalanges may also occur. Synostoses between the distal and middle phalanges may occur. Subluxations have been reported.

The calcinosis may be due to the fact that calcium remains in solution in live tissue which has an acid reaction but when tissue is dead and the reaction becomes alkaline calcium is deposited.—Audrey G. Morgan.

#### ROENTGEN AND RADIUM THERAPY

PATERSON, RALSTON. Radiotherapy and the cancer act. *Brit. J. Radiol.*, Oct., 1942, 15, 297-301.

The application of the Cancer Act of 1939 after the war promises to have a profound effect on radiotherapy. It requires the creation of cancer diagnostic services and the provision of adequate treatment by both surgery and radiotherapy. A table of cancer incidence is given showing the enormity of the task to be faced. A large part of the difficulty in the effec-

tive treatment of cancer has lain in the failure to diagnose the disease early either from neglect of the symptoms on the part of the patient or failure of the general practitioner to recognize them for what they are. This should be corrected by having diagnostic clinics in charge of specialists trained in the diagnosis of cancer in every community so that no patient would have to travel far for examination.

In contrast with this decentralization in diagnosis there should be large cancer units for treatment, each one serving a population of not less than a million people, yielding about 900 cancer cases. In thinly populated sections it might be possible to establish a unit for each half million people, though efficiency in treatment would probably increase up to two million. The radiotherapists who treat cancer should be full-time specialists. The deep therapy equipment should be concentrated in the major treatment centers. The surgical treatment of cancer should also be centralized in these large cancer units.

It is much better psychologically for hopeless cancer patients to be treated at home. Some scheme should be devised by which adequate home nursing could be provided. This should be a much more complete nursing service than is provided by the daily visit of a district nurse.—*Audrey G. Morgan.*

ELLINGER, FRIEDRICH. The problem of recovery from radiation effects. *Radiology*, Jan., 1943, 40, 62-71.

According to the point of view of photochemistry, irradiation produces toxic substances in the body from the disintegration of cells. Recovery takes place either by these substances being recombined into their original forms by a reversible chemical action or by their being removed by diffusion. The circulation plays an important part in the latter process.

Clinical recovery means the restoration of organ structure and function. This may result from the recovery of their normal function by cells that have been injured, in which case it is true recovery. Or it may result from proliferation of cells that have escaped injury which take the place of the injured cells. This is called pseudo-recovery. Experimental work on various kinds of tissue is described which seems to show that the greater part of the recovery after irradiation is pseudo-recovery. The tissues most capable of recovery are those with a high power

of regeneration, such as skin, testicles and hair follicles. Recovery depends on the regenerative power of the irradiated tissue, the dose of irradiation, the time in which the dose is given and the blood supply of the tissue.

The recovery of tumors from the effects of irradiation is of great clinical importance. Probably pseudo-recovery takes place in tumor tissue just as it does in normal tissue, as tumor tissue has very great regenerative power. The fact that some tumors become radioresistant after a certain amount of irradiation seems to confirm this theory.—*Audrey G. Morgan.*

FINZI, N. S. Management of x-ray reactions. *Brit. J. Radiol.*, July, 1942, 15, 192-193.

In a discussion before the Faculty of Radiologists, Finzi stated that there is some difference in the local reactions to 200 kv. and 1,000 kv. roentgen rays. With the shorter wave lengths the reactions were sharper but subsided more quickly and kept drier. For the same biological effect more roentgens of the higher voltage are required in the proportion of 3 to 2.

Skin erythema was less severe when the skin was kept dry and no ointments used. During treatment starch powder gave relief. After treatment a mixture of either calamine or zinc and starch powder with an equal quantity of bismuth carbonate was used. For vesication, linamentum calaminae with 2 grams of phenol per ounce was effective. Acute ulceration was relieved by an ointment of 5 per cent benzocaine or cycloform in vaseline. For chronic ulceration sulfonamides, sulphathiazole or flavine in paraffin or castor oil were satisfactory. Ultraviolet treatment was not found satisfactory.

Mucous membrane reactions were earlier than skin reactions and passed off sooner. Heavy irradiation devitalized bone so that spontaneous fractures failed to heal. Diarrhea was caused by the action of the rays on the intestines. Ten gr. salol three times a day was good for this condition. The lungs are very radiosensitive and lung injuries difficult to treat. Operation through tissue devitalized by operation is dangerous.

For general reactions such a nausea and vomiting adrenalin in 10 minim doses every hour until relieved was very effective. Vitamin C in 3,000 gm. doses has also been recommended. Liver extract was not found to be of any value. Large doses of iron were useful.—*Audrey G. Morgan.*

SMITHERS, D. W. Control and treatment of radiation reactions. *Brit. J. Radiol.*, Aug., 1942, 15, 233-236.

The general reactions to radiation include the generalized skin reactions, the effects on the blood count and the symptoms known as roentgen sickness, such as anorexia, nausea and vomiting. A study of roentgen sickness has shown that it is most apt to occur in nervous, high-strung patients in poor general health who are given frequent large integral doses to a large radiosensitive tumor. Charts are given showing the integral doses administered in certain types of tumor. Good results have been obtained in roentgen sickness by giving injections of vitamin B and histaminase.

The blood count seems to be favorably affected by the administration of vitamin C and recently sodium bicarbonate has been given in conjunction with the vitamin C with good results. It promotes the storage of the vitamin in the body. Vitamin C often brings about an increase in the total cell count and the lymphocyte count even while treatment is being continued with the same integral dose each day.—*Audrey G. Morgan.*

#### MISCELLANEOUS

WEATHERALL, M. The pharmacological actions of some contrast media and a comparison of their merits. *Brit. J. Radiol.*, May, 1942, 15, 129-137.

A study was made of the pharmacological actions of 7 contrast media containing iodine. Four of them were found unsuitable for clinical use. One of them that showed promise in experimental work was found to be poorly tolerated by human subjects. This left three worthy of use for pyelography and a clinical testing of their value in angiography, particularly cerebral angiography for which no satisfactory medium has as yet been found. These three are diodone, which is sold under the trade names of perabrodil and diodrast, iodoxyl, the pharmacological name of uroselectan B, and sodium o-iodohippurate, which is sold as hippuran.

Their effects on heart, blood vessels and blood pressure were tested and tracings showing the results are given. It was found that diodone is the most suitable medium for use in pyelography, cardiography and angiography. It was given by intracarotid injection to cats to test its suitability for cerebral angiography and is believed worthy of clinical testing for this purpose.—*Audrey G. Morgan.*

MEYER, H. The quantitative determination of radium by a photographic method. *Brit. J. Radiol.*, March, 1942, 15, 85-91.

A method of photographic quantitative determination of radium with a very simple apparatus is described and a diagram of the apparatus given. It is simple and the main sources of error in other photographic methods, such as variations of the emulsions of different films and uneven blackening are overcome by it. It consists of two identical lead blocks 20 cm. high, 15 cm. long and 10 cm. wide standing 25 mm. apart on a wooden support. The radium source is placed centrally between the two blocks and the radiation filtered through a lead filter. The films should be processed in total darkness as the blackening produced by a darkroom safe-light may introduce errors up to 20 per cent. Development should follow exposure as soon as possible as a delay of twenty-four hours or more may cause an error. Densities should preferably be measured by a microphotometer but if this is not available a Weston photronic foot-candle meter, model 614, or a similar instrument may be used.

This method is particularly adapted for measuring weak sources of radiation. In order to shorten the exposure time, which is long for such preparations, the distance between the radium source and the film may be decreased.

The photographic method of course cannot replace air ionization methods for precision measurements in large institutions but is especially adapted for use in chemical laboratories where considerable amounts of open radium salts and solutions are used, and isolated measuring rooms and the services of skilled physicists are not available.—*Audrey G. Morgan.*



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## RADIUM METABOLISM IN RATS, AND THE PRODUCTION OF OSTEOGENIC SARCOMA BY EXPERIMENTAL RADIUM POISONING\*

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### INTRODUCTION

TWENTY to thirty years ago the internal administration of radium salts was a moderately popular but misguided therapeutic measure. In 1924 Blum<sup>2</sup> identified radium as the responsible agent in an occupational poisoning case resulting in osteomyelitis of the mandible and maxilla. The clinical and pathological studies of Martland and others<sup>4,6,16</sup> soon disclosed a number of cases of occupational radium poisoning acquired primarily in the radium dial painting industries during World War I. Other cases of fatal radium poisoning soon appeared, resulting from the oral or intravenous administration of radium, or other radioactive substances such as mesothorium.

With varying degrees of success, several clinicians have undertaken to relieve cases of chronic radium poisoning by treatment employing parathormone therapy,<sup>1,12,13</sup> or by a low calcium diet,<sup>26</sup> and based primarily on the close biochemical similarity between calcium and radium.

Clinically, cases of radium poisoning may be divided into acute and chronic types, with the usual continuum of intermediate cases. The acute cases result from the fixation in the skeleton of relatively large quantities of radium, and are characterized by a short and invariably fatal course accompanied by a marked secondary anemia, leukopenia, extensive hyperplasia of bone marrow, and pathological changes in the kidneys and other soft tissues. Rarefaction and spontaneous fractures of bone are common. In chronic cases, resulting from the fixation in the skeleton of relatively small quantities of radium, the course of the disease is much longer, lasting from five to fifteen or twenty years. There is often no deviation from a normal blood count, tissue abnormalities are much milder, and osteogenic sarcoma is often seen as a terminal condition.

Because of the interesting possibility that suitable clinical treatment may relieve some cases of chronic radium poisoning, clinical and experimental studies are of

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special interest. In recent years it has become possible to make accurate physical analyses on patients, whereby quantitative data on the radium burden, the radium metabolism and the radium excretion may be relied upon. A few representative cases have been published.<sup>1</sup> Unpublished data on a number of patients, seen by Dr. H. S. Martland of Newark and Dr. J. C. Aub of Boston, have served to emphasize the large biological variations between individuals in the radium dosage and the radium burden required to produce the usual clinical symptoms of chronic radium poisoning. In general, chronic radium poisoning is eventually seen in individuals containing from 1 to 10 micrograms of radium. Due to wide biological variations some patients containing only 2 micrograms of radium have been more quickly and more seriously affected than others containing as much as 20 micrograms of radium.

The clinical symptoms of chronic radium poisoning ordinarily appear only after a lapse of five to fifteen years from the time the radium entered the body. Thus in any individual patient the full course of the disease has seldom, if ever, been observed clinically. Some patients have been seen immediately after an accidental ingestion of radium, others shortly after the onset of the first clinical symptoms many years after radium was taken into the body, and still others have been seen only terminally. To assist in gaining a better clinical understanding of the full course of chronic radium poisoning it has seemed worth while to imitate the disease in experimental animals, where the time elapsed between the administration of radium and death might be compressed to one or two years. Previous studies of experimental radium poisoning in animals<sup>15,20,21,23,27</sup> have involved such large dosages that the animals imitated acute radium poisoning, usually exhibiting marked blood changes and never living long enough to develop sarcomas, except in the work of Sabin, Doan and Forkner,<sup>23</sup> who obtained osteogenic sarcomas in 2 out of 7 rabbits in eleven to nineteen months.

Accordingly, between 1936 and 1941 we have induced chronic radium poisoning in four series of male albino Wistar rats. Extensive quantitative observations of the metabolism of radium have been made in the first three series. The highlights of these observations and some comments on the pathological conditions induced are reported in the present paper. Primary osteogenic sarcoma is a terminal symptom in some of these experiments. The full course of the disease in these animals correlates well with both published and unpublished observations on patients seen for short periods at various stages of the long course which chronic radium poisoning runs in man. Pathological studies were emphasized in the fourth series of animals, which is being reported in a separate paper.<sup>5</sup> The osteogenic sarcomas induced in the fourth series of animals have been successfully transplanted by C. E. Dunlap and have now been carried through more than seven serial generations of rats. This should provide an interesting source of experimental material for laboratory studies of osteogenic sarcoma, especially with the use of artificially radioactive calcium, strontium, and other elements, when war-time activities allow a return to such investigations.

When these experiments were begun there was very little quantitative information relating to the minimum dosage required to produce injury in man. We therefore hoped that the rat experiments might be useful in estimating a tentative tolerance value for human beings. Tolerance data are obviously of importance to the United States Food and Drug Administration and to other agencies involved in the control of radium nostrums, and in the protection of personnel in industries using radioactive materials. The enormous expansion of the radium dial painting industry during the present war has given new urgency to the problem of determining a reasonable figure for the tolerance value in humans.

The very great difference which exists between species in resistance to toxic substances always introduces a profound un-



certainty in the extrapolation of any animal result to man. The tolerance values in animals may be interesting where there is an absolute lack of observations on man, but even a few measurements on man must be regarded as overwhelmingly more important in determining the tolerance dosage for man than the most elaborate experiments on animals.

Unpublished observations by Drs. J. C. Aub and R. D. Evans now include 7 human cases in which more than  $0.02 \mu\text{g.}$  and less than  $0.5 \mu\text{g.}$  of radium has been carried for some seven to twenty-five years without the appearance of any clinical symptoms of chronic radium poisoning. On the other hand, several unpublished cases seen by these workers, and others seen by Dr. H. S. Martland, have resulted fatally when the burden was between  $0.5$  and  $2 \mu\text{g.}$  of radium. These observations have led to the tentative establishment<sup>24</sup> by a committee of the National Bureau of Standards of  $0.1 \mu\text{g.}$  of radium fixed in the body as the tolerance value for humans. This figure replaces tolerance values of  $10 \mu\text{g.}$  and  $1.0 \mu\text{g.}$  recommended by individual observers<sup>19</sup> a number of years ago, before adequate physical methods were available for detecting smaller quantities of radium in living human beings. Whether or not the present tentative tolerance value of  $0.1 \mu\text{g.}$  of radium is also optimistic when applied to a large group of individuals can be determined by accurate routine physical studies of the many hundreds of individuals who have entered the radium dial painting profession during the present war.

#### ANIMAL LABORATORY PROCEDURES

*Series I.* The 11 male albino rats used in this series were obtained directly from the Wistar Institute, were fifty-five to sixty days old and 214 to 267 grams in weight at the start of the experimental period. They were separately housed in  $12 \times 6 \times 6$  inch galvanized wire cages, and fed a good stock diet<sup>22</sup> and glass-distilled water *ad libitum*. The cages rested on Glasbak dishes of such size that all food, urine and feces falling from above would be recovered.

Six of the animals were kept as controls. The remaining 5 received supplemental radium by medicine droppers, beginning November 2, 1936. The radium was diluted with physiological saline and glycerine so that 4 drops fed daily for twenty days would contain the desired quantity of radium. Glycerine was used to make the feeding more palatable. Drinking water was removed from the cages each evening and returned each morning after the thirsty rats had been given the supplemental feeding.

The droppings into the dishes below the cages were removed twice weekly, each collection being placed into a 16 oz. wide mouth glass-stoppered bottle, the dish was washed with 10 successive amounts of 1 M hydrochloric acid (saturated with barium chloride) and the dish returned to its place for the next collection. Thus any radium remaining on these dishes was carried into the subsequent collection. The collected samples were stoppered and sealed with wax to prevent the escape of radon generated by the radium in the sample. At the conclusion of the experiments the cages and trays were analyzed and found to have retained a negligible amount of radium.

The attendant feeding the rats wore rubber gloves which were washed with acid solution at the end of each day's feeding and these washings were collected. At the end of the feeding period the ampules, droppers and bottles used in feeding were placed in the jar containing the glove washings, and sealed. The radium in this jar represented that which had not been fed.

The radium used in this series was contained in 2 cc. ampules in the form of a halide. The ampules for animals No. 16212, 16213, 16214 contained radium as radium chloride in isotonic saline (U. S. Radium Corp.). The ampules for animals No. 16834 and 16835 contained radium as radium bromide in distilled water, with less than 3 per cent as much barium as radium (Luminous Processes, Inc.). Each ampule was analyzed for radium by the gamma-ray method before being opened. The amount of radium actually used in the experiments was determined by subtracting the radium content of the empty ampules, droppers, bottles and glove washings from the radium content of the ampules.

*Series II.* Six male white rats were obtained from Wistar Institute, were fifty-three to

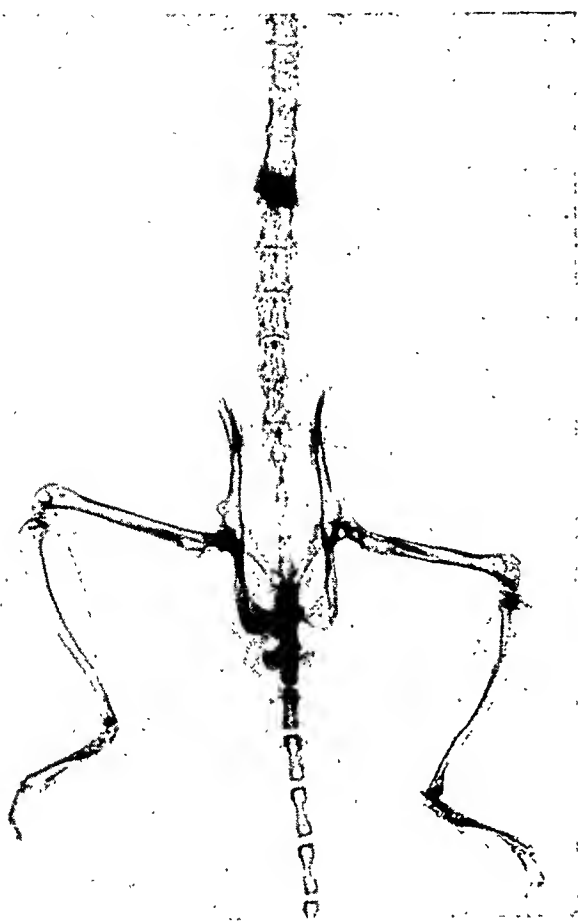


FIG. 1. Roentgenogram showing osteogenic sarcoma in lumbar vertebra of rat No. 16212, at death.

sixty-five days old and weighed 233 to 250 grams at the start of the experimental period. The procedure was substantially the same as in Series I. However, the experiment was started seventeen months later, June 10, 1938, and the radium element was fed daily for ten days to 3 rats, as a bromide compound (Luminous Processes, Inc.) in isotonic saline and glycerine, the remaining 3 animals being kept as controls. The actual quantities fed were estimated by the same procedure. Each day during the radium administration the excreta were collected and subsequently analyzed for radium content.

*Series III.* Concurrently (June 15, 1938) with Series II, 6 Wistar rats, fifty-three to sixty-five days old and weighing 215 to 244 grams were subjects in an experiment in which 3 of the experimental rats were given the radium intradermally at the midline of the abdomen. A mixture of 5 cc. distilled water, 181 micrograms of radium as bromide, 80 milligrams of barium chloride and 0.94 cc. of physiological saline solution was used for the injection. Each

animal received five injections of 0.3 cc. each, at two-day intervals, from this solution. As in the other series, the actual amount of radium used was calculated from the results of measurements of the radium remaining in the containers after injections had been made.

*Series IV.* Thirteen male Wistar Institute rats, twenty-one weeks old, were fed three drops (0.13 cc.) per day for twenty days, of a solution containing 1,500  $\mu$ g. of radium (supplied as crystalline bromide by the S. W. Shattuck Co., Denver) in 13 cc. of glycerine, and 26 cc. of 0.9 per cent sodium chloride. Correcting for the measured radium content of the feeding bottle and dropper at the end of the experiment, each animal in this series received 100  $\mu$ g. of radium element. The feedings were begun on January 13, 1941. In about a year 9 of these animals developed osteogenic sarcomas, reported in detail elsewhere.<sup>5</sup>

The laboratory data on Series I, II, and III are presented in Table I. Most of the animals died during the experimental period but in several cases they were killed. The general procedure used in preparing tissues for radium assay was as follows: Thoracic and abdominal cavities were opened, and the lungs, kidneys, liver, heart, spleen, testes and viscera of each animal were each placed in a separate bottle. The muscle tissue and skin were removed as completely as possible and placed in another bottle. Then the skull, spine and tail, ribs, pelvic girdle, fore legs and scapula, and hind legs were each placed in bottles. The weighed contents of each bottle were digested with nitric acid on a steam bath until the acid solution was relatively clear. This nitric acid was prepared from Grasselli c.p. reagent nitric acid by redistillation in glass, retaining only the center 90 per cent cut. Control tests on the prepared acid showed it to be free from radium and its decay products.

After digestion of the samples, the bottles were stoppered and sealed with wax. This complete separation of tissues and organs was not made in preparing the first animals to die in Series I and in several instances samples were taken for pathological examination and not analyzed for radium content.

#### PATHOLOGICAL FINDINGS

*Series I.* Rat No. 16212 developed an osteogenic sarcoma in the upper lumbar vertebra (Fig. 1). He died 438 days after

the first radium feeding. On postmortem he showed marked cystitis, enlarged kidney showing albuminous degeneration of the proximal convoluted tubules. Some regions of the bone showed distortion of the normal architecture with occasional islands of cartilage. In other areas the marrow was replaced by highly vascularized fibrous tissue with fibroblasts varying in size and shape and rarely showing mitotic figures. The spleen showed increased fibrosis of

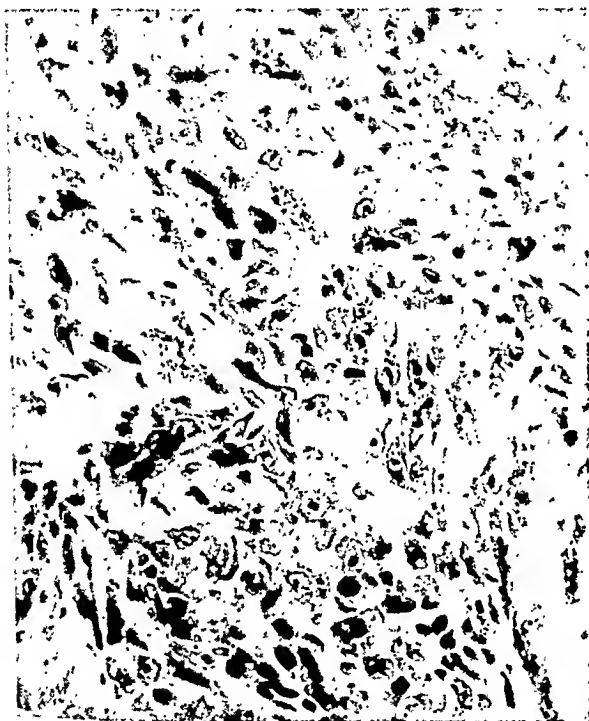


FIG. 2. Rat No. 16213. Lung metastasis. Hematoxylin-eosin. ( $\times 400$ )

trabeculae in the reticulo-endothelial cells; some arterioles showed moderate hyaline thickening. The heart and liver were negative. Death was probably due to ascending infection of the urinary tract. Microscopic section showed osteogenic sarcoma. Tumor of the spine contained 39.5 units of phosphatase per gram, by the method of Franseen and McLean.<sup>14</sup>

Rat No. 16213 was killed 537 days after first radium feeding. At postmortem there was a small abscess near an old fracture of the right tibia, a lung abscess about 7 mm. in diameter, and several metastases (Fig. 2)

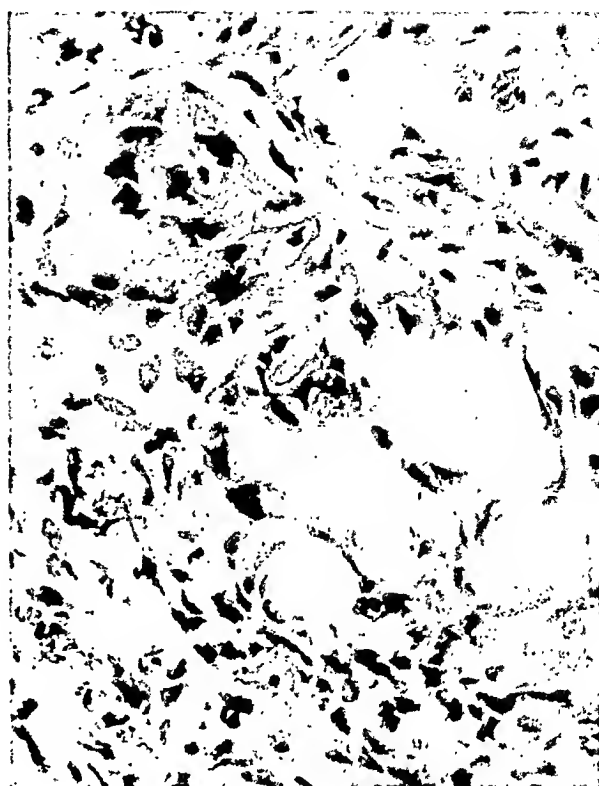


FIG. 3. Rat No. 16213. Section of the original tumor (osteogenic sarcoma) in the right femur. Hematoxylin-eosin. ( $\times 400$ )

in the lungs, each about 3 mm. in diameter. A tumor, 1 cm. in diameter, occupied the upper end of the right femur (Fig. 3) and

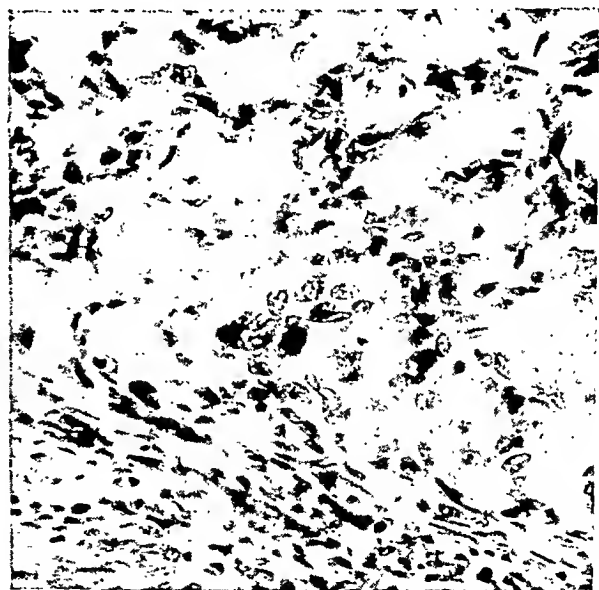


FIG. 4. Rat No. 16213. Metastasis in spleen, with uninvolved splenic tissue in lower left corner. Hematoxylin-eosin. ( $\times 400$ )

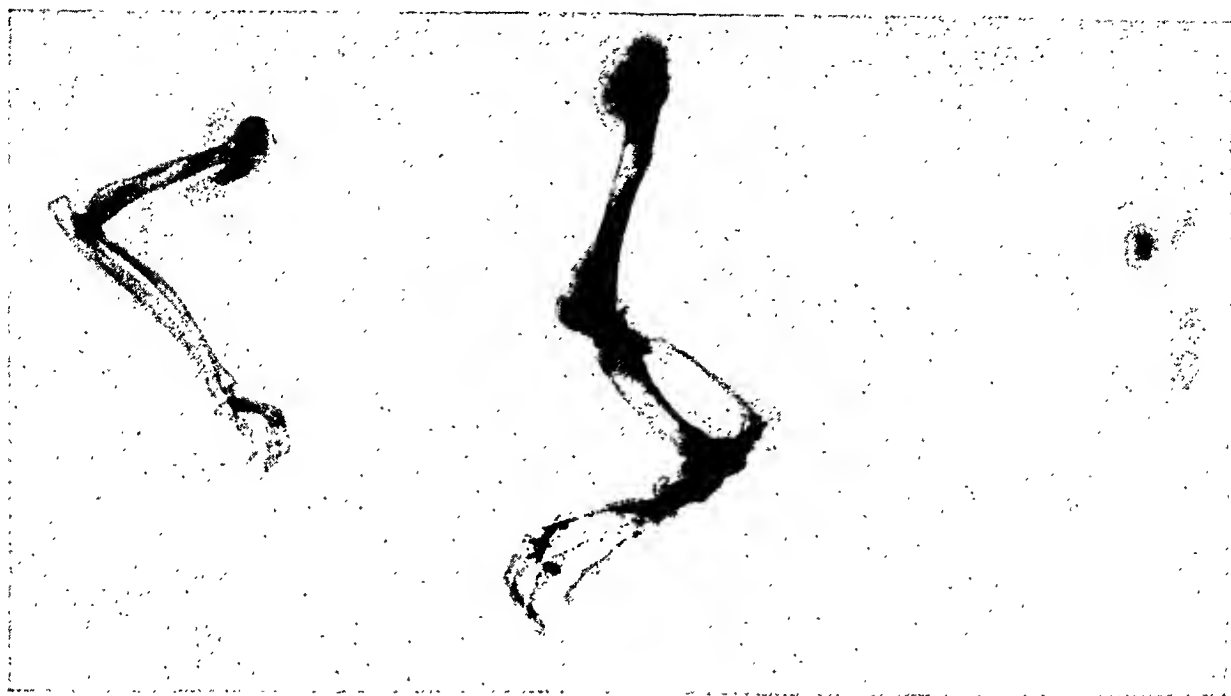


FIG. 5. Roentgenograms of sarcomatous left arm and right leg, and of calcified spleen, all from rat No. 16213, at the time of death.

contained encapsulated bone spicules. A second tumor was present at the upper end of the right humerus which was softer and more granular than the femur tumor, but the same size. The spleen was largely replaced by five discrete metastases (see Fig. 4, also roentgenogram, Fig. 5); the largest was  $10 \times 5 \times 6$  mm. and perhaps was composed of two foci. Each was stony hard, and had white bone-like centers. The liver and other abdominal organs had no metastases. The tumor from the humerus (see roentgenogram Fig. 5) showed irregular masses of fibroblasts varying somewhat in size, with numerous tumor giant cells and infrequent mitoses. There was considerable collagen and a slight deposition of osteoid, resembling a poorly differentiated sarcoma, though occasionally there were foci of well formed trabecular osteoid with a suggestion of calcification. The tumor from the femur (see roentgenogram, Fig. 5) was much less cellular, with relatively plump fibroblastic cells peripherally; and with rather sparse more or less elongated, fibroblastic cells, and rare mitoses. Peripherally there was a slight amount of intercellular collagen and virtually no osteoid. Cen-

trally there was a moderate amount of osteoid and some fairly dense, partially hyalinized collagen, appearing like a moderately well differentiated osteogenic sarcoma. The lung contained several small foci of well formed osteoid, with some calcification, the surrounding cells being irregular in size and shape with rather dense, pyknotic nuclei and occasionally showing mitotic figures. Not only did the tumor invade the lung parenchyma but it grew freely within some of the great vessels as well. The adjacent lung parenchyma showed moderately intense inflammatory reaction probably due to secondary infection. The spleen showed nodules of tumor very similar to that present in the femur, with much osteoid and hyaline, fibrous tissue; a moderate number of irregular polyhedral tumor cells was scattered throughout the substance of the tumor. Here and there mononuclear cells filled with hemosiderin were present. The kidney showed albuminous degeneration of the convoluted tubules. The glomerular tufts were somewhat edematous, otherwise not remarkable. The phosphatase content of the femur tumor was 42.7 units per gram

while that of the metastases of the spleen was 55.0 units per gram.

Rat No. 16214 died 558 days after the first feeding of radium. During the last eighty days of this period he lost considerable weight. Roentgenograms taken at death showed evidence of osteogenic sarcoma in the pelvic region of the spine, but this was not confirmed by pathological examination. The lungs were filled with multiple small abscesses, confirmed by frozen sections.

Rat No. 16834 died 377 days after first radium feeding. He showed a mass in the pelvis by roentgen examination (Fig. 6) and a tumor at autopsy. Death came early in a weekend and the tissues were too necrotic for satisfactory study. However, tumor was represented by irregular strands of bone and osteoid tissue ( $25 \times 11 \times 10$  mm.) presenting various degrees of calcification. The irregularity in architecture and general distortion, the relation of the bone and osteoid trabeculae to the necrotic soft tissues warrant a diagnosis of osteogenic sarcoma. Pelvic tumor contained 98.6 units of phosphatase per gram and 0.037 microgram of radium per gram, and weighed about 1.5 grams.

Rat No. 16835 died 383 days after first feeding of radium. Before pathological study, the right leg was removed for chemical analysis (see Table III). The lung was irregularly infiltrated by clusters of large



FIG. 6. Roentgenogram showing sarcoma in the pelvis of rat No. 16834, at death.

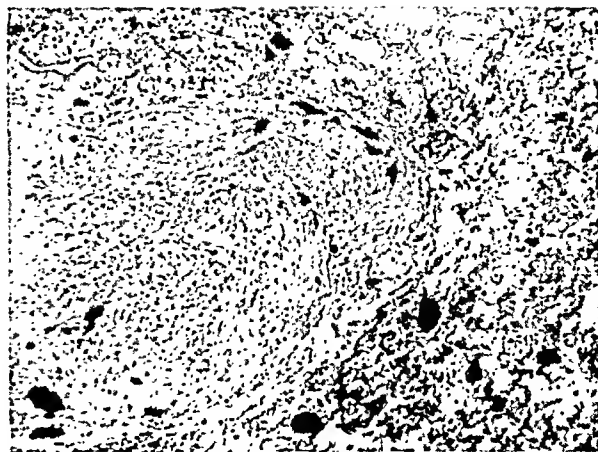


FIG. 7. Rat No. 16835. Low power view of nodule in lung invading normal lung tissue. Hematoxylin-eosin. ( $\times 60$ )

fibroblastic cells arranged in somewhat irregular strands, invading and destroying normal lung parenchyma (Fig. 7). There was moderate variation in the cytologic picture, some tumor giant cells being present. Mitotic figures were moderately frequent. There was a slight amount of collagenous intracellular substance present. The remainder of the lung showed some fibrosis and infiltration with polymorphonuclear leukocytes, lymphocytes, and mononuclear leukocytes. There was some purulent exudate in the bronchi. Rare vessels showed thromboses. The section of bone available for study appeared within normal limits except for irregularity of cartilage in the region of the epiphyseal line, and moderate variation in the contour of adjacent bone trabeculae. There was slight fibrosis and paucity of hematopoietic cells in the marrow adjacent to the epiphyseal line. The liver showed a few foci of trabeculation and rarefaction of the cell columns about the central venules. The kidney showed considerable postmortem change with varying albuminous degeneration of the proximal convoluted tubules, and the glomeruli were not remarkable. The testes were not unusual, but the spleen showed some diffuse fibrosis.

*Series II.* Rats No. 20950, 20951, and 20952 died 455 to 462 days after the first feeding of radium. The apparent cause of

death was pneumonia. Roentgenograms taken during the test period and after death showed no evidence of osteogenic sarcoma or of tumors.

*Series III.* Rat No. 20953 died 224 days after the first injection of radium. He had lost 35 grams in weight during the last sixty-one days of life. Death may have been due to bronchopneumonia. Pylone-

*Series IV.* Of the 13 animals in this series, 9 developed primary osteogenic sarcomas in time intervals of 253 to 426 days after the first radium feeding. The average induction time of the tumors was 365 days. The primary growths were in the vertebrae in 7 rats and in the pelvic bones in two. Complete pathological findings have been described elsewhere.<sup>5</sup>

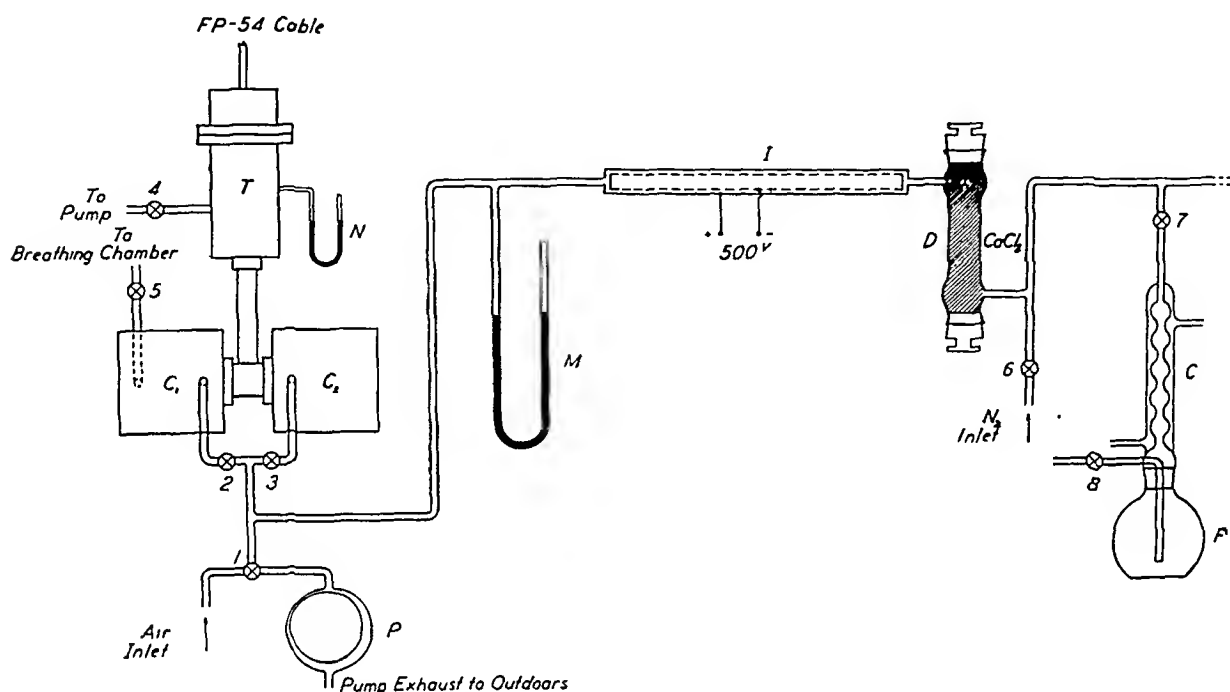


FIG. 8. Schematic diagram of the apparatus for measuring the radium content of tissues, bones, and excreta.

phritis was noted on microscopic examination, but the bone was negative and no tumors were found.

Rat No. 20954 died 302 days after the first radium injection. He had lost 105 grams in weight during the last 139 days of life. Microscopic examination showed tubular nephritis, eburnation of the bone with slight fibrosis, and no tumors.

Rat No. 20955 was killed 143 days after the first radium injection. He had lost 28 grams in weight during the last forty-seven days of life. At the end there developed complete paralysis of both hind legs but no cause for this could be found on post-mortem examination, though it may have resulted from the hydronephrosis which was found. No evidence of tumor was noted.

*Controls.* The control animals for each of the four series were given the same environment and dietary and differed only in that they received no radium. Their weight increased throughout the test periods. After the last animal in each group had died, the controls for that group were roentgenographed. None showed evidences of sarcoma or tumors. Since they appeared to be normal, these animals were used in successful attempts to transplant the osteogenic sarcomas which had appeared in the test animals.

#### MEASUREMENT OF RADIUM IN EXCRETA AND IN POSTMORTEM MATERIALS

The balanced double ionization chamber method,<sup>7</sup> modified primarily by substituting a vacuum tube electrometer<sup>18</sup> for the

string electrometer, is used for measuring the radon accumulated in and released from solutions of bones, tissues, and excreta. The radium content of the sample is then obtained by the usual elementary calculation.

A schematic diagram of the complete radon measuring apparatus is shown in Figure 8. Stopcocks 2 and 3 allow independent pumping of the two balanced ionization chambers,  $C_1$  and  $C_2$ . Each ionization chamber is about 13 cm. in length and diameter, has a volume of 1.89 liters, has brass walls and a 1 mm. brass center wire, has tapered pressed-amber insulators with guard rings, and contains a renewable cartridge of  $P_2O_5$  for keeping the insulation thoroughly dry. The electrometer tube chamber  $T$  can be evacuated through stopcock 4, the manometer  $N$  serving only as a rough indicator of the pressure.

In operation, one chamber, usually  $C_1$ , is pumped out, the pressure being read by a mercury manometer at  $M$ . The solution containing the radium and radon is in flask  $F$  and is boiled for twenty minutes, nitrogen meanwhile bubbling through the solution after entering at stopcock 8. The radon and nitrogen pass through the water-cooled condenser  $C$ , the  $CaCl_2$  drying tube  $D$ , and the ion trap  $I$ , into  $C_1$ , the rate of flow being such that the pressure in  $C_1$  reaches one atmosphere at the end of the twenty-minute period. Stopcocks 2, 7, and 8 are then shut off, the amplifier attached to the  $FP-54$  cable is balanced, and the photographic record of the amplified ionization current is begun. Using a grid resistor of 94,000 megohms the sensitivity was  $8.25 \times 10^{-9}$  curies per volt change in grid voltage.

Following each analysis, the ionization chambers are pumped out and filled with nitrogen which enters at 6. Four or five flushings with nitrogen are sufficient to clean the chambers of all residual radon.

#### BREATH MEASUREMENTS ON THE LIVING RATS

At various times during the experiments all of the rats were measured for the radon

content of their exhaled breath. For this purpose an ionization chamber ( $C$  in Fig. 9) was built with a removable extension ( $R$ ) in which the rat is housed. At the junction are two polished plates ( $P_1, P_2$ ) with two 1 inch holes cut in each. These act as a valve, enabling the ionization chamber to

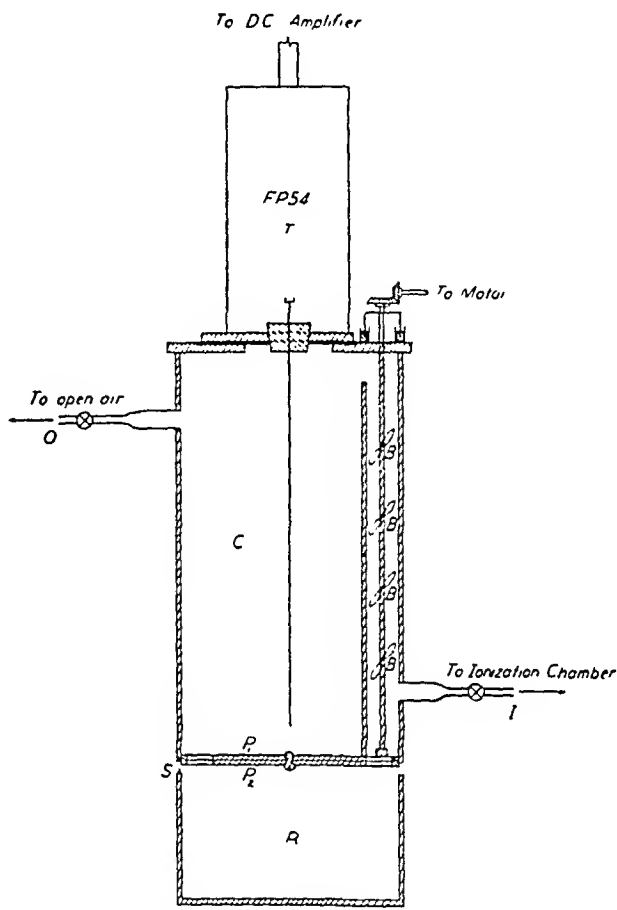


Fig. 9. Cross-section of the ionization chamber and rat breathing chamber for measuring the rate at which the rats exhaled radon.

be isolated from the rat breathing chamber ( $R$ ) by rotating the rat chamber  $90^\circ$ .

Each rat is kept in the chamber for five or ten minutes and then the chamber is sealed off and the rat removed. While the rat is in the chamber a mercury sealed stirrer ( $B$ ) mounted near the side of the ionization chamber circulates the radon and air throughout the chambers  $C$  and  $R$ . The radon exhaled by the rat is calculated from the radon measured in  $C$  (volume = 5,590 cc.) by correcting for the volume of the rat chamber (1,380 cc.) minus the volume of the rat (assuming specific gravity equals



1.0). Thus the total radon  $Rn$  is given by

$$Rn = Rn'(6970 - m)/5590$$

where  $m$  is the weight of the rat, and  $Rn'$  is the amount of radon measured in chamber  $C$ . The radium  $Ra$  producing this radon is given by

$$Ra = Rn/\lambda T$$

where  $\lambda = 2.1 \times 10^{-6} \text{ sec}^{-1}$  is the decay constant of radon, and  $T$  is the number of seconds the rat breathes in chamber  $R$ .

The radon in  $C$  is measured by an  $FP-54$  vacuum tube electrometer,<sup>18</sup> whose sensitivity is such that  $7.67 \times 10^{-9}$  curies of radon in  $C$  produces a change in grid potential of one volt. Calibration is made by flowing radon produced in a standard radium solution through  $C$  and through  $C_1$  of Figure 8 in series at atmospheric pressure. By measuring the radon in  $C_1$ , and the volume of both  $C_1$  and  $C$ , the radon introduced in  $C$  can be determined accurately. The chamber  $C_1$ , which can be evacuated, is calibrated separately in the usual way,<sup>7</sup> using a dilute standard radium solution obtained from the National Bureau of Standards.

#### GAMMA-RAY MEASUREMENTS ON LIVING RATS

Most of the rats were measured with a Geiger-Müller counter for gamma-ray activity, by comparison with a known standard at the same distance from the counter tube. The rat was housed in a small cage  $6 \times 3 \times 3$  inches in size. The bottom, sides, and ends were then fitted with pieces of corrugated cardboard to prevent the rat from changing his position. Guides along the top of the cage held the counter in a fixed position relative to the rat. The data were recorded with a counting rate meter.<sup>9</sup>

It was necessary to correct these data for absorption of the gamma rays in the rat. The detailed method developed for use on human beings<sup>8</sup> was modified by including higher algebraic terms in the expansion leading to equation (9) of that paper in order to account for the larger ratio between animal thickness and the separation

between animal and counter. It was found that the rats had a mean effective thickness of 6 cm., that the mean absorption coefficient for radium series gamma rays was  $0.073 \text{ cm.}^{-1}$  in the bones and tissues of the rat, and that the inverse square law becomes an inverse 1.4 power law when the counter is parallel to and 9 cm. from the long axis of the rat, and an inverse 1.8 power law at 20 cm. This deviation from the inverse square law is to be expected because neither the counter nor the animal represents mathematical points, but have dimensions comparable to the distance between them.

The results of the radium measurements on all three series of rats are given in Table I.

#### EXCRETION AND RETENTION OF RADIUM

Radium analyses were made on each individual sample of mixed feces and urine, representing biweekly collections from Series I, and daily collections from Series II and III during the feeding or injection period and for a short time thereafter. Collections containing more than about  $0.2 \mu\text{g.}$  of radium were simply sealed and stored for a month to permit the establishment of radioactive equilibrium. Then their gamma-ray activity was compared with that of standard radium solutions, using screen cathode gamma-ray counters<sup>11</sup> and a counting rate meter. Corrections were applied for the internal absorption of the radium C gamma rays within the sample.\* Collections containing less than about  $0.2 \mu\text{g.}$  of radium were digested in redistilled nitric acid and their radium content determined by measurements of their rate of production of radon.

Measurements of the actual radium content of the living rats were made using the techniques described in the previous section, the total radium content being the sum of the amounts of radium required to produce the radon in the exhaled breath

\* The method of Patterson, Walsh, and Higgins<sup>17</sup> was generalized to include correction terms for the decrease of gamma-ray intensity with distance, for each volume element in the cylindrical source.

TABLE I  
SUMMARY OF THE RADIUM MEASUREMENTS

Animal Number	Series I—Oral					Series II—Oral			Series III—Injected		
	16212	16213	16214	16834	16835	20950	20951	20952	20953	20954	20955
Attempted dosage, $\mu\text{g. Ra}$	50	50	25	100	100	50	50	50	50	50	50
Probable dosage, $\mu\text{g. Ra}$	22	28	10	62	70	40	26	24	6	4	3
Weight in grams. Initial	231	245	233	267	264	250	233	242	240	215	221
Maximum	341	320	388	386	386	358	340	354	330	315	342
Final	233	310	300	386	393	332	304	350	295	210	314
Days survival after beginning Ra	438	537	558	377	383	462	455	462	224	302	143
Suggested cause of death	Nephro- sis	Killed	Pneu- monia	Un- known	Un- known	Pneu- monia	Pneu- monia	Pneu- monia	Broncho- pneu- monia	Nephritis	Killed
Developed osteogenic sarcoma	Yes	Yes	Probable	Yes	Probable	No	No	No	No	No	No
<i>Radium measurements on living rats</i>											
Days after beginning radium	381	427	394	245	309	170	175	178	190	193	195
$\mu\text{g. Ra}$ as exhaled breath Rn	0.01	0.71	0.27	4.4	3.0	0.36	0.62	0.68	3.2	1.7	1.3
$\mu\text{g. Ra}$ as gamma rays from body	0.12	0.13	0.04	0.46	0.79	0.07	0.10	0.12	1.1	0.8	0.8
$\mu\text{g. Ra}$ total in living body	1.03	0.84	0.31	4.86	3.8	0.43	0.72	0.80	4.3	2.5	2.1
Percentage body Ra shown as breath Rn	88	84	87	90	79	84	86	85	74	68	62
<i>Radium measurements postmortem</i> ( $10^{-9}$ gm. Ra/gm. wet weight)											
Kidney	0.0075	—	0.053	0.023	0.046	0.000	0.018	0.075	0.31	0.25	0.08
Spleen	0.004	—	—	0.006	0.043	—	—	0.11	0.027	2.7	0.15
Liver	0.0008	—	0.0005	0.015	0.017	0.015	0.0046	0.009	0.26	0.12	0.010
Intestines	—	—	0.25	—	—	0.0054	0.060	0.030	—	—	—
Heart	0.02	—	0.004	0.015	0.15	0.002	0.018	0.005	0.0006	0.12	0.0005
Lungs	0.69	—	0.10	1.8	1.1	0.12	0.087	3.7	0.11	0.47	0.38
Testes	—	—	—	—	—	0.031	—	0.009	0.33	—	0.004
Muscle, skin and fur	0.005†	—	—	0.006†	0.09†	0.31	0.68	0.50	—	20	—
Legs	—	—	13	—	—	48	58	49	83	70	—
Arms and scapula	—	—	14	—	—	45	35	50	86	80	—
Spine including tail	—	—	24†	—	—	26	34	30	54	50	—
Pelvis	—	—	—	—	—	—	47	46	73	81	—
Skull and teeth	—	—	32	—	—	36	51	60	62	86	—
Ribs	—	—	—	—	—	24	17	45	94	78	—
Entire skeleton	90	60	25	400	400	34	42	43	79	68	—
<i>(<math>10^{-9}</math> gm. Ra in total tissue)</i>											
Kidney	0.022	0.030	0.21	0.061	0.12	0.0005	0.022	0.15	0.57	0.063	0.046
Spleen	0.001	0.043	—	0.001	0.029	—	—	0.022	0.073	0.26	0.014
Liver	0.003	—	0.002	0.043	0.12	0.097	0.031	0.055	2.2	0.46	0.066
Intestines	1.3	0.58	4.9	2.2	2.6	0.070	0.74	0.36	—	—	—
Heart	0.014	0.005	0.008	0.015	0.33	0.004	0.036	0.010	0.0009	0.089	0.001
Lungs	1.9	1.8	0.19	4.2	3.0	0.25	0.18	7.20	0.40	0.45	0.058
Testes	—	0.47	—	—	0.07	0.017	—	0.040	0.29	—	0.015
Muscle, skin and fur	0.013†	15.7	—	0.012†	0.23†	33.6	62.7	59.9	3400	2100	—
Legs	—	108	16	—	—	76	117	113	333	171	—
Arms and scapula	—	66	21	—	—	40	31	45	175	75	—
Spine, including tail	—	282	146†	—	—	102	186	180	320	265	—
Pelvis	—	61	—	—	—	—	47	55	118	131	—
Skull and teeth	—	127	58*	—	—	123	158	191	424	248	—
Ribs	—	42	—	—	—	12	8	27	108	47	—
Entire skeleton	918	632	241	3970	3790	353	547	611	1478	937	—
Total Ra in all tissues, $\mu\text{g}$	1.0	0.67	0.28	4.4	4.2	0.42§	0.61	0.68	4.9	3.0	2.1
Total Ra excreted during life, $\mu\text{g}$	21.0	27.0	10.0	58.0	66.0	40.0	25.0	23.0	1.5	0.9	0.5
Total Ra, excreta and tissues, $\mu\text{g}$	22.0	27.7	10.3	62.4	70.2	40.4	25.6	23.7	6.4	3.9	2.6
Percentage Ra retention at death	4.5	2.4	2.7	7.0	6.0	1.0	2.4	2.9	77	77	80

\* Lower jaw removed.

† Ribs, spine, tail, scapula and pelvis.

‡ Leg muscle only.

§ Including 0.03  $\mu\text{g}$ . estimated for pelvis.

and to produce the gamma rays emitted from the rats' bodies. Radium analyses were also made postmortem, by the radon method, on the principal organs and tissues, and on the skeletons.

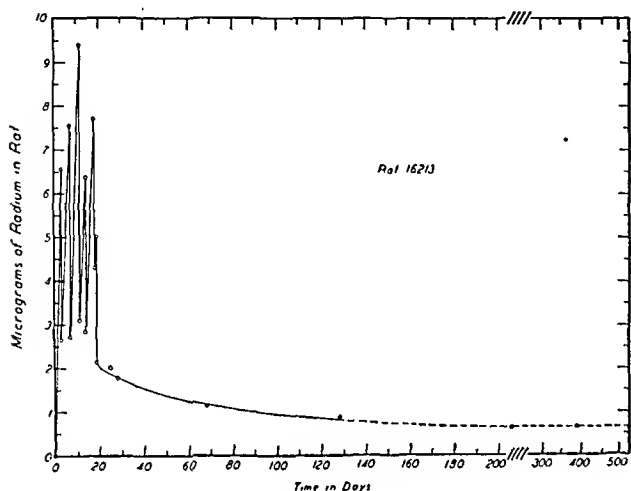


FIG. 10. Retention of radium, in micrograms, in rat No. 16213 which was fed a total of 28 micrograms of radium in twenty daily doses. The animal retained 2.8 per cent of the dose at the time of death, 537 days after the beginning of the radium feeding. Osteogenic sarcoma was demonstrated (Fig. 5).

Originally, the actual amount of radium administered to each animal was estimated by deducting from the measured strength of the radium preparations the amount of

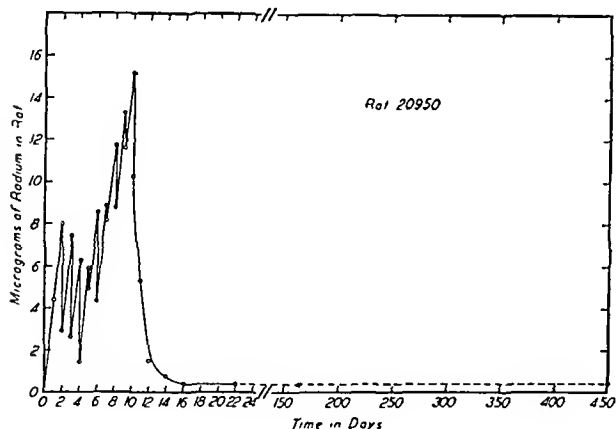


FIG. 11. Retention of radium in micrograms, in rat No. 20950, which was fed a total of 40 micrograms of radium in ten daily doses. The animal died of pneumonia 462 days later, having retained only 1.0 per cent of the radium fed. See Table I. Note the unusually rapid excretion of radium during and immediately following the administration of the radium.

radium remaining on the glassware, gloves etc., used in administering the dosage. Subsequently, this dosage estimate was compared with the sum of the total body content at death and the total excreta of each animal. The agreement was poor, in some cases as much as 40 per cent of the originally estimated dosage being unaccounted for in the excreta and body of some individual animals. Therefore in Table I, and in the graphs of the dosage and excretion of the individual animals, we have chosen the sum of the body radium at death and the total excretion during life as the best evaluation of the actual dosage for each individual animal.

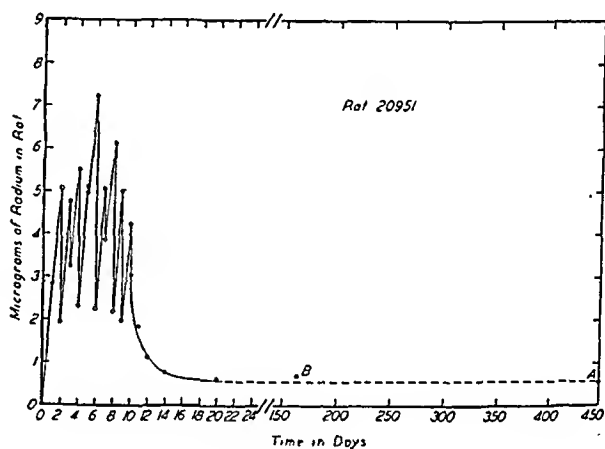


FIG. 12. Retention of radium, in micrograms, in rat No. 20951, fed a total of 26 micrograms of radium, and retaining 2.4 per cent of it at death. Point A is radium found in bones and tissues postmortem; point B is radium in living animal determined from the sum of body gamma rays and exhaled breath radon.

In Series II and III, the entire skeletal musculature, plus the skin and fur, was analyzed for radium, but this was not done in Series I. The results from Series II indicate that after oral administration about 10 per cent of the total radium is found in the muscle, skin and fur sample. An unknown fraction of this radium may be external. In estimating the total dosage and retention for Series I, we have added 10 per cent of the measured skeletal radium content, to represent the radium content of the total muscle, skin and fur.

The excretion of ingested radium in rep-

representative animals from Series I and II is shown in Figures 10, 11, and 12. The solid portion shows the increasing radium content resulting from the administered dosages, determined as described above, and the loss of radium by excretion in the feces and urine.

The rapid initial excretion of ingested radium is evident. Within four days from

ured (Table I, Fig. 11 and 12) on the live animal. The higher fractional excretion rate in animal No. 20950 than in the other two animals was consistent with his smaller fractional retention of radium (see Fig. 11 and 12).

A few radium measurements were made during the lifetime of 4 of the 13 animals (No. 25630, No. 25631, No. 25632, No.

TABLE II  
SUMMARY OF THE RADIUM MEASUREMENTS ON SERIES IV

Animal Number	No. 25630	No. 25631		No. 25632		No. 25633
Total radium fed, $\mu\text{g}$ .	100	100		100		100
Days survival after beginning Ra	253	318		398		398
Developed oosteogenic sarcoma	Yes	Yes		Yes		Yes
<i>Radium Measurements</i>						
Days after beginning Ra	110	113	309	106	323	320
$\mu\text{g}$ . Ra as exhaled breath Rn	3.12	1.53	1.42	1.85	1.72	1.23
$\mu\text{g}$ . Ra as gamma rays from body	0.45	0.38		0.27		
$\mu\text{g}$ . Ra total in living body	3.57	1.91	ca 1.97	2.12	ca 1.97	ca 1.45
Percentage body Ra shown as breath Rn	87	80		87		
$\mu\text{g}$ . Ra excreted per day	0.0050	0.0036				
Percentage Ra excreted per day	0.14	0.19				
Percentage average daily excretion, 100 to 300 days		0.034		0.034		

the last administration of radium, 92 to 96 per cent of the total radium administered has been excreted. As in the case of humans (ref. 1; Case R.L.) this initially rapid fractional rate of excretion declines rapidly. A seven day collection of excreta from each animal in Series II was made 120 days after the conclusion of the feeding. These collections contained 0.016, 0.017, and 0.022  $\mu\text{g}$ . of radium for animals No. 20950, No. 20951, and No. 20952 respectively. This corresponds to a daily elimination rate of 0.6 per cent, 0.3 per cent, and 0.4 per cent, respectively, of the body content as meas-

ured (Table I, Fig. 11 and 12) on the live animal. The higher fractional excretion rate in animal No. 20950 than in the other two animals was consistent with his smaller fractional retention of radium (see Fig. 11 and 12).

A few radium measurements were made during the lifetime of 4 of the 13 animals (No. 25630, No. 25631, No. 25632, No. 25633) of Series IV for body gamma rays, exhaled breath radon, and rate of radium excretion. These observations are summarized in Table II. All 4 animals died of osteogenic sarcoma and have been described pathologically in another place.<sup>5</sup> About 110 days after beginning the radium feeding the radium excretion rate for 2 animals was about 0.15 per cent per day, while the average excretion rate over the last seven months of life was 0.035 per cent per day. The 4 animals tested showed an average total radium retention at death of 2.2  $\mu\text{g}$ ., or 2.2 per cent of the amount fed.

Thomas and Bruner<sup>27</sup> found an average radium excretion rate of 0.09 per cent per day near the end of life in 2 rats which had received radium by subcutaneous injection.

Aub, Evans, Gallagher and Tibbetts<sup>1</sup> studied 1 patient who accidentally inhaled a small quantity of radium. They found an average daily excretion rate of about 2 per cent of the radium contained in the body four weeks after the accident, when the patient still contained about 0.8 microgram of radium. Seven weeks after the accident the patient contained 0.6 microgram of radium, and excreted about 1 per cent per day, while still on a normal high calcium diet. Medication was then instituted to maintain as high a rate of radium excretion as possible, and in the three weeks (from the ninth to twelfth week after the accident) the average excretion rate was 0.7 per cent per day. Six months later the patient was re-examined and found to have retained about 0.3 microgram of radium, of which 0.1 per cent was being excreted daily.

Studies on a number of chronic human cases have shown an average daily fractional excretion rate of about 0.005 per cent per day,<sup>1,8,25</sup> after radium has been in the body for several years.

In man, about 45 per cent of the radon produced by radium in the skeleton is exhaled, although this percentage may vary widely in exceptional cases. The remainder of the radon decays within the body into a series of solid radioactive products, one of which, radium C, emits strong gamma rays. Thus about 55 per cent of the body radium in man is usually exhibited as body gamma rays.

In the rats, the percentage of radon exhaled is much higher, as would be expected from their higher metabolic rate and their smaller size which allows for the more rapid transport of radon from the bones to the lungs. Both Series I and II (as well as 3 of the animals in Series IV) showed an average of 85 per cent of the body radium exhibited during life as radon in the exhaled breath,

only the remaining 15 per cent giving rise to gamma rays from the body.

In a series of human beings who drank known quantities of a radium nostrum, from 0.1 to 10 per cent of the radium ingested was fixed chronically in the skeleton.<sup>10</sup> This fractional retention appears to increase with increasing dosage, and also to be dependent on the dietary calcium balance at the time of ingestion. An adequate calcium intake, prior to radium ingestion, probably minimizes the fixation of radium in the bones because of the close biochemical similarity between radium and calcium. In the animals studied, the terminal fractional retention after oral ingestion (Series I, II and IV) varies between 1 and 7 per cent, and may indicate an increase with increasing dosage.

At postmortem, the organs contain less than 1 per cent as much radium per gram as is found in the skeleton. The muscle, skin, and fur samples of Series II contained about 10 per cent as much radium as the skeleton. However, the low radium content of the leg muscle samples in Series I suggests that skeletal muscle also has a very low radium content. The possibility that the skin and fur were contaminated by radium from excreta cannot be excluded in our measurements on Series II.

Of the organs studied, the lung generally has the greatest and the heart the least concentration of radium per gram of tissue (Table I). On the wet weight basis used throughout, the bones usually show at least a hundred times the radium concentration of the richest soft tissue. There is no remarkable variation in radium concentration from one bone to another, although the spine and ribs appear to exhibit the lowest concentration of radium per gram of bone. However, if comparisons on a dry weight basis were possible, the relative concentrations might be altered or even reversed because of the small amounts of cortical bone in the spine.

The distribution of total radium in the skeleton placed about 65 per cent in the axial system of skull and spine, some 7 per

cent in the fore quarters (scapula, arms, and hands), and about 28 per cent in the hind quarters (pelvis, legs, and feet).

In Series III, radium was administered by intradermal injection at the midline of the abdomen, but only about 10 per cent of the radium entered the animals. The remainder was found in the vials and syringe where it was apparently adsorbed by the glass in spite of the excess of barium chloride present in the neutral solution, which was prepared as described in the section on Animal Laboratory Procedures.

measurements on the live animals showed that there was a concentration of the radium at the site of injection even six months after the injections were made, and the high concentration of radium found in the skin of these animals at postmortem confirmed this. It is apparent, therefore, that the higher excretion rate in the injected series is due to the normal excretion of the radium which had entered the body upon injection and was first deposited in the tissues, plus an excretion of small amounts of radium which had been held



FIG. 13. *A*, roentgenogram of hind quarters of control rat No. 16833. *B*, roentgenogram of hind quarters of rat No. 16835. Both roentgenograms were taken 289 days after first feeding of radium to rat No. 16835. Note intense calcification in metaphysis of tibia and femur of radium-fed rat.

The initial absorption following intradermal injection was slow, as shown by an initially low radium excretion rate which increased slightly with time, following the injections, and which then decreased much more slowly than in the animals given radium by mouth. In the injected animals the rate of radium excretion decreased by one-half approximately every two weeks. This rate of decrease is much slower than was noted in Series II. The route of administration should not affect the rate of excretion of metabolic radium. The unabsorbed radium in the ingestion experiments would be eliminated within five days and subsequent excretions represent the elimination of metabolized radium. Direct gamma-ray

at the site of injection and had only recently entered the body circulation.

During life these injected animals also exhibited only about 60 to 75 per cent of their radium as radon in their exhaled breath. Taking the average value of radon exhaled from the skeletal radium as 85 per cent, as found in Series I and II, this smaller fractional radon exhalation rate shows that the circulation of blood through the skeletal parts was much greater than through the area where the undiffused injected radium was entrapped in the dermal tissues. It is likely that a greater fraction of the radon produced in this area disintegrated without being carried by the blood stream to the lungs for exhalation.

In Series III, the fractional retention of radium actually reaching the circulation can be estimated by excluding the radium found in the tissues. Taking only the radium in the organs and skeleton and excreta, the fractional retention is  $1.5/(1.5+1.5) = 50$  per cent for animal No. 20953, and  $0.94/(0.94+0.9) = 51$  per cent for animal No. 20954. Thomas and Bruner<sup>27</sup> found about 25 per cent retention of radium chloride injected subcutaneously in rats.

bones of a rat (No. 16212) whose tibia was accidentally broken while roentgenograms were being taken seventy days after the beginning of the radium feeding period. At this time the radium was primarily located in the skeleton. Roentgenograms showed a dense structure at the area where the bone had healed. Autoradiographs (Fig. 14) show that there was also a high concentration of radium in this area.

The radium concentration in the osteo-

TABLE III  
CALCIUM, PHOSPHORUS AND RADIUM CONTENT OF TIBIA AND FIBULA  
OF RADIUM POISONED RAT AND CONTROL RAT

Tissue	Weight	Extracted Dry Weight			Ra/Ca
		Calcium	Phosphorus	Radium	
	(gm.)	(gm./gm.)	(gm./gm.)	(gm./gm.)	(gm./gm.)
Tibia epiphysis	0.15 (0.12)	0.17 (0.15)	0.08 (0.07)	$210 \times 10^{-9}$	$1.3 \times 10^{-6}$
Tibia shaft	0.28 (0.22)	0.22 (0.21)	0.11 (0.10)	400	1.8
Femur epiphysis	0.16 (0.10)	0.18 (0.20)	0.08 (0.09)	250	1.4
Femur shaft	0.38 (0.15)	0.21 (0.17)	0.10 (0.08)	350	1.7

In these analyses the right legs of rat No. 16835 were used. Bones were separated then cut through the metaphysis. Analyses on control No. 16216 are given in parenthesis.

Mention should be made of the fact that the administration of radium causes a hypercalcification of the long bones. This is evident in Figure 13 which shows an intense shadow in the metaphyseal areas of the tibia and femur, indicative of dense calcium deposits. Chemical analysis has shown that there is a tendency for these bones to contain more ash, calcium and phosphorus than the tibia and femur of a control animal (Table III). As these rats were young adults, these results indicate that a different type of bone was produced after the radium was administered.

A similar observation was made on the

genetic sarcoma of animal No. 16834 was  $37 \times 10^{-9}$  grams Ra per gram of tumor, or only about 10 per cent of the radium concentration in the skeletal bones of the same animal, but the calcium concentration was not measured.

The distribution of radium in whole bone is not uniform (Fig. 14). These autoradiographs were made by sectioning the bone with a razor blade, mounting at the surface of a paraffin block and then placing on a photographic plate (Wratten and Wainright, Metallographic) with a thin sheet of cellophane separating the section from the photographic emulsion.



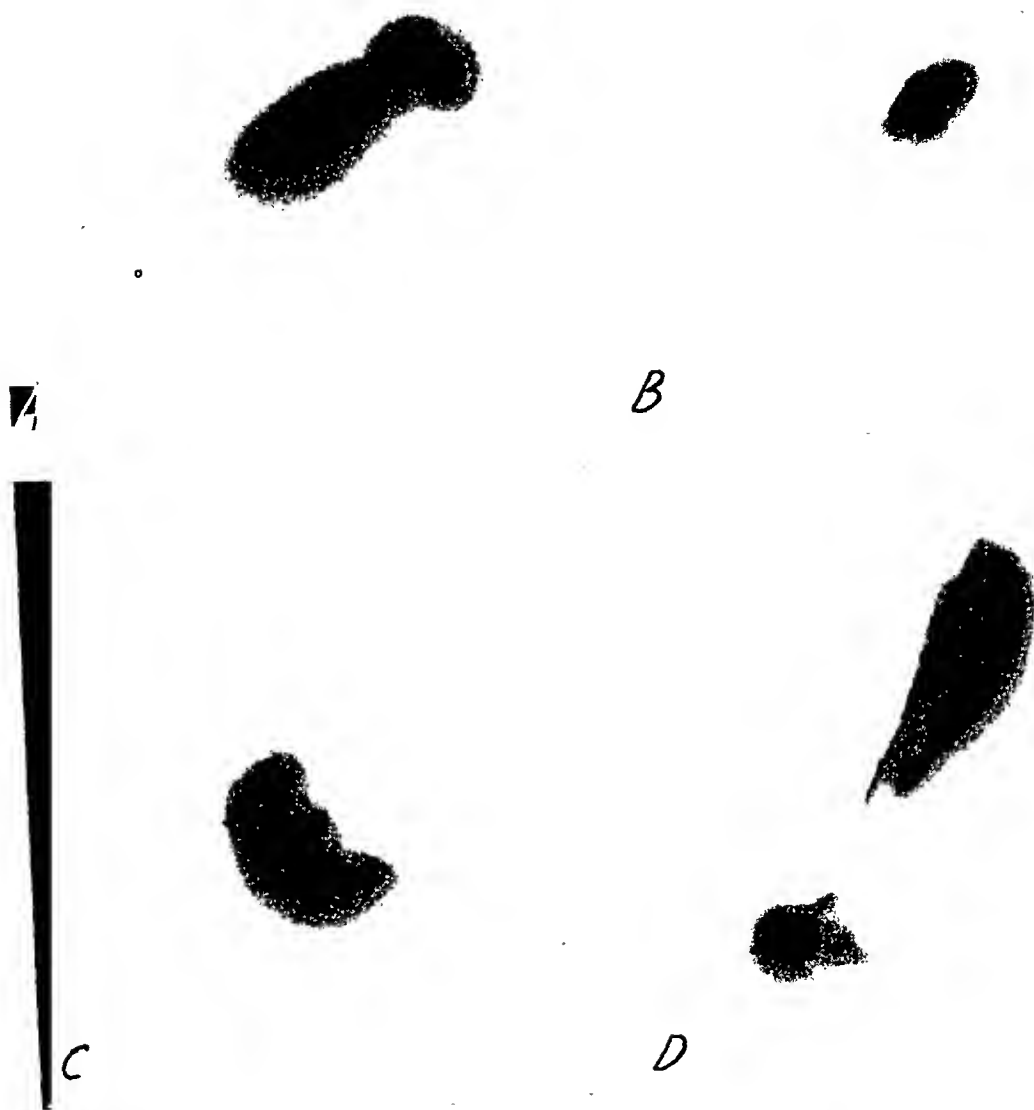


FIG. 14. Autoradiographs of bones. *A*, normal humerus of rat No. 16834. *B*, broken and healed humerus of rat No. 16834. *C*, broken and healed humerus of rat No. 16212, broken seventy days after radium feeding was begun, and noted fully healed five months later. *D*, normal vertebra of rat No. 16212.

While the living animals were being roentgenographed, the leg bones of several were broken. As this occurred with none of the control animals, it is evident that the bones of the radium treated rats were brittle. This is in agreement with the previous observation by Thomas and Bruner.<sup>27</sup>

#### BLOOD FINDINGS

On November 23, 1937, 386 days after the animals in Series I had been given radium orally, a sample of blood was taken from the test and control rats and analyzed. The results are shown in Table IV.

With the exception of No. 16213, all

TABLE IV

RESULTS OF ANALYSES OF BLOOD TAKEN FROM SERIES I AND II CONTROLS,  
386 DAYS AFTER RADIUM WAS FED

Rat number	16215	16216	16212	16213	16214	16834	16835
Probable Ra Dosage (micrograms)	0	0	22	28	10	62	70
Red cells (million/mm. <sup>3</sup> )	7.8	7.6	2.2	7.0	6.8	7.3	2.9
White cells (thousands/mm. <sup>3</sup> )	12.8	11.2	10.4	19.0	14.6	5.4	12.0
Small lymphocytes (per cent)	29.0	29.0	21.0	32.0	26.0	20.0	37.0
Large lymphocytes (per cent)	16.0	21.0	20.0	8.0	12.0	31.0	16.0
Monocytes (per cent)	15.0	21.0	4.0	6.0	10.0	11.0	13.0
Eosinophils (per cent)	0.0	1.0	4.0	0.0	1.0	2.0	0.0
Hemoglobin (gm/100 cc.)	9.8	9.4	8.7	8.2	9.2	8.4	4.5

TABLE V

RELATIVE MAINTENANCE AND TOXIC DOSES OF VITAMINS AND  
MINERALS PER KILOGRAM WEIGHT<sup>1</sup> OF MAN AND RAT

Substance	Grade of Toxicity	Per Kilogram				Rat/Man Ratio
		Rat		Man		
		Maintenance Dose <sup>2</sup>				
Vitamin A		180	IU	70	IU	2.6
Vitamin D		18	IU	6	IU	3.0
Thiamine		0.060	mg.	0.026	mg.	2.3
Riboflavin		0.075	mg.	0.039	mg.	1.9
Iron		0.75	mg.	0.17	mg.	4.4
Calcium		154	mg.	11	mg.	14.0
Phosphorus		180	mg.	14	mg.	12.9
		Toxic Dose <sup>3</sup>				
Arsenic <sup>4</sup>	Chronic	0.05	mg.	0.01	mg.	5.0
Barium <sup>5</sup>	Acute	118	mg.	11	mg.	10.7
Copper <sup>6</sup>	Acute	35	mg.	7	mg.	5.0
Lead <sup>7</sup>	Acute	3556	mg.	142	mg.	25.0
Lead <sup>8</sup>	Chronic	2.13	mg.	0.014	mg.	152.0
Mercury <sup>9</sup>	Acute	36.6	mg.	14	mg.	2.5
Radium <sup>10</sup>	Chronic	0.003	mg.	0.00002	mg.	150.0
Selenium <sup>11</sup>	Chronic	0.3	mg.	0.05	mg.	6.0
Thallium <sup>12</sup>	Acute	25.0	mg.	10.0	mg.	2.5

<sup>1</sup> Calculations are based on 70 kg. man and 0.33 kg. rat.<sup>2</sup> The vitamin and mineral allowances for man are those of the National Research Council.<sup>a</sup> Maintenance dose for rats represents usual allowances in nutrition research.<sup>3</sup> With the exception of radium data, the toxic doses and appended notes were prepared by Dr. H. O. Calvery of the U. S. Food and Drug Administration.<sup>4</sup> Arsenic figures for man derived from report of the Royal Commission appointed to inquire into the Manchester beer poisoning.<sup>b</sup><sup>5</sup> Barium dose for man is the probable fatal dose (Sollmann<sup>c</sup>): that for rat is LD<sub>50</sub> as determined in the laboratories of the Division of Pharmacology of the U. S. Food and Drug Administration.<sup>6</sup> Copper dose for man is emetic dose (Sollmann<sup>c</sup>): dose for rat is that causing depressant effect as determined by the Division of Pharmacology of the U. S. Food and Drug Administration.<sup>7</sup> Acute dose of lead for man is lowest reported fatal dose (Sollmann<sup>c</sup>): doses for rats are LD<sub>50</sub> for lead acetate as determined by the Division of Pharmacology of the U. S. Food and Drug Administration.<sup>8</sup> Chronic dose for man is taken from data of Kehoe and coworkers<sup>d</sup> where the blood and urine lead, in the case of two individuals, receiving known amounts of lead three times daily, in a well-controlled experiment over a long period of time, reached levels often

radium-fed rats showed polychromatophilia. Rats No. 16212 and 16835 showed anisocytosis. Rats No. 16834 and 16835 both showed increased nucleated red cells, indicating abnormal functioning of the bone marrow.

There was no correlation between the red cell count and the amount of radium in the bodies of the rats, though the red cell count of all test animals was lower than that of the controls. Two showed very low red cell counts and in 1 of these (No. 16835) the hemoglobin reading was also low.

The white cell data were variable and do not bear a relationship to the radium content. The high value in No. 16213 may be the result of an infected leg which he had at the time. Rat No. 16835 had the poorest blood picture and was the only one who had exhibited tumors when these samples were taken.

#### EFFECT OF RADIUM ON DISTRIBUTION OF BONE CALCIUM

The roentgenograms of radium poisoned rats all show an opacity in the metaphyseal region, indicating hypercalcification (Fig. 13). An attempt to confirm this by chemical analysis was made by study of the

right femur and tibia of rats No. 16835 (radium fed) and No. 16216 (control). The bones were prepared by severing the flesh-free bones axially near the metaphysis with a razor blade. The resulting specimens were weighed, dried, extracted, weighed, ashed, weighed and then analyzed for calcium and phosphorus content. The results of these analyses are presented in Table III. There does not seem to be a significant difference between the two series of results.

Of especial interest is the average ratio of radium to calcium ( $1.5 \times 10^{-6}$ ) presented in Table III. Examination of the tibia and fibula of one human subject<sup>1</sup> who died with osteogenic sarcoma resulted in a Ra/Ca ratio of  $6 \times 10^{-9}$ , or 250 times lower.

One may conclude from this that the rat is not an acceptable animal for the estimation of the lethal dose of radium in man. Extrapolation of rat results on the basis of body weight, body surface, skeletal weight or blood volume does not approximate the lethal dose for man. A similar conclusion was reached recently by Calvery.<sup>3</sup> That body weight is a doubtful basis for extrapolating data obtained on man or rat is shown clearly in Table v which presents the estimates of therapeutic and toxic

observed in cases of recognized lead poisoning, although these two individuals were not reported to show other signs of lead poisoning. Chronic dose for rat is the smallest to produce symptoms with lead acetate.<sup>a,f</sup>

<sup>9</sup> Mercury dose is for bichloride. Human dose is that reported by Sollmann<sup>e</sup> as having survived prompt treatment, but fatal otherwise. Rat dose is LD<sub>50</sub> as determined by the Division of Pharmacology of the U. S. Food and Drug Administration.

<sup>10</sup> Radium dose for humans is taken from recent unpublished measurements by H. S. Martland, J. C. Aub, and R. D. Evans on three patients containing 0.9, 1.1, and 1.5 micrograms of radium. Death from radium poisoning has been observed in one patient containing only 0.5 microgram of radium.<sup>8</sup> Rat data taken from animals No. 16212 and 16213 who died with osteogenic sarcoma. The radium doses, for both man and rat, refer to radium retained in the body.

<sup>11</sup> Selenium dose for man is the median estimated dose to produce symptoms as calculated by M. I. Smith and coworkers.<sup>h</sup> Dose for rat is lowest dose producing definite pathological changes as found by the Division of Pharmacology of the U. S. Food and Drug Administration.

<sup>12</sup> Thallium dose for man is that reported as toxic but allowing recovery.<sup>i</sup> Dose for rat is that given by Sollmann and Hanzlik<sup>1</sup> as the minimum lethal dose.

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doses of a selected group of compounds and elements. The rat/man ratio, on the basis of equal body weights, varies between 2 and 152.

#### SUMMARY

1. Chronic radium poisoning has been studied in four series of young adult male Wistar rats; twenty-one were given radium by mouth, and three by intradermal injection.

2. Apparatus is described for measuring the radium content of living rats, using gamma rays from the body and the radon content of the exhaled breath. The breath radon accounts for 85 per cent of the radium content of the living animal. Radium measurements were also made on the excreta, and on postmortem material.

3. Oral administration of 25 to 100 micrograms of radium resulted about a year later in a high incidence of primary osteogenic sarcoma, usually in the vertebrae and with metastases in the lung and other organs. The sarcomas are transplantable. Pathological findings are reported.

4. Following oral administration over a period of ten to twenty days, only 4 to 8 per cent of the radium was retained in the animal four days after the last feeding.

5. At death, 1 to 7 per cent (average 3 per cent) of the radium administered orally remained in the animal's body. About 50 per cent of the radium injected intradermally was retained at death. A terminal retention of 1 microgram of radium is sufficient to produce osteogenic sarcoma. At death, over 90 per cent of the retained radium is found in the skeleton. The bones show at least 100 times the radium concentration of the richest soft tissue (lung).

6. Many of the classical symptoms of chronic radium poisoning in human beings were exhibited by these animals. The radium stimulates a hypercalcification at the ends of the long bones. The bones become fragile, but heal satisfactorily, exhibiting a marked concentration of radium at the site of repair.

7. The incidence of anemia was low. Only moderate disturbances of the normal

blood picture were noted, and there was no correlation with the radium content of the various animals.

8. The rat cannot be used for obtaining an estimate of the toxic dose of radium in man. It is shown that the toxic dose, per kilogram body weight, is greater in the rat than in man by factors varying from about 2.5 to 150 for eight toxic metals. To produce chronic symptoms similar to those in man, the rat requires some 150 times as much radium per kilogram body weight, and some 250 times the skeletal ratio of radium to calcium as does man.

We wish to record our thanks to Dr. Herbert O. Calvery and Dr. J. C. Aub for many stimulating discussions during the course of these experiments, to Dr. Shields Warren, Dr. Clifford Franseen, Dr. Olive Gates, and Miss R. McLean for the pathological studies, and to Dr. Austin Brues for preparing the photomicrographs of the pathological sections.

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# INTRATHORACIC HODGKIN'S DISEASE\*

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THE typical case of Hodgkin's disease with discrete, painless enlargement of peripheral lymph nodes is well known and has been thoroughly described. However, not only peripheral lymphoid tissue but also that of the spleen, bone marrow, lungs, pleura, liver, muscles, skin and digestive tract may be involved; and the frequency of such involvement is less well recognized. The intrathoracic manifestations of Hodgkin's disease are of particular interest because of the varied character of the disease in the chest, and its close similarity to other more common lesions of the lungs.

A series of histologically proved cases of Hodgkin's disease has been studied from the standpoint of intrathoracic involvement including that of mediastinal lymph nodes, pulmonary parenchyma, pleura, heart and bony thorax. This study was prompted by the observation of several cases referred with a diagnosis of pulmonary tuberculosis which on further observation were found to be intrathoracic Hodgkin's disease without evidence of tuberculosis. This series has been reviewed to determine what proportion shows intrathoracic involvement which might, therefore, be confused with some other disease of the chest. In all cases the diagnosis was proved by autopsy or biopsy or both. Not included in this series are cases of other lymphomatoid diseases such as lymphosarcoma. While the latter may have similar roentgenologic findings and follow much the same clinical course, this study is of Hodgkin's disease alone.

## INCIDENCE

It is recognized that the only unequivocal way to demonstrate intrathoracic disease is by chest roentgenography, biopsy, or autopsy. The limitations of physical examination alone are apparent,

for only masses of relatively large size are recognized by their physical signs or by symptoms produced by their location. Furthermore, these physical signs of tumor are not pathognomonic of Hodgkin's disease alone. Only proved cases, therefore, have been collected in this series studied by autopsy or biopsy, and in which roentgenograms were available. There are 55 such cases. Of these, 35 cases, or 63 per cent, showed intrathoracic involvement.

## CLASSIFICATION

Numerous classifications of intrathoracic Hodgkin's disease have been proposed.<sup>5,9,13,15</sup> For the purposes of study and presentation, these cases have been grouped according to the involvement of the main anatomical structures of the thorax, that is, the mediastinum, thymus gland, lung, pleura, heart and bony cage. It must be recognized that because of the tendency of this disease to be widely disseminated most cases will overlap from one type to another, and the classification is determined by the structure which is predominantly involved. Fifteen cases have been selected to illustrate the varied involvement of the organs of the thorax under the headings of (I) *mediastinal*, (II) *parenchymal*, (III) *pleural*, (IV) *osseous* and (V) *cardiac types*.

Regardless of the etiologic factors concerned, Hodgkin's disease is characterized anatomically by marked involvement of lymphoid tissue. The character of the disease in any organ, or region of the body, will therefore be determined by the location of its lymphoid tissue and the degree to which it is affected by the etiologic factor. The protean manifestations of intrathoracic Hodgkin's disease can be correlated with the anatomical distribution of lymphoid tissue within the chest, for it is abun-

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dantly supplied with such tissue of which the three major accumulations are those of the mediastinum, lung parenchyma and pleura.

### I. Mediastinal Types

The mediastinal variety is the most common in this series since 50 per cent of the cases fall in this group. The mediastinum contains an extensive collection of lymph nodes consisting of the small nodes of its anterior and posterior divisions; the more numerous nodes extending along the trachea (the paratracheal nodes); the nodes in the hilum at the angles of the trachea and major bronchi, and in the carina (the tracheobronchial nodes); and those at the angles of the larger bronchial branches (the bronchopulmonary nodes).

The manifestations of the disease will depend on the extent and degree to which these various groups of nodes are affected. If the nodes are generally involved, massive, lobulated mediastinal shadows are noted in the roentgenogram (Case III). More frequently, however, discrete enlargement of nodes is present. In our series, the hilar nodes are the most commonly involved, the localized enlargement suggesting other lesions such as carcinoma, tuberculosis and sarcoid (Case I). Enlargement of the right paratracheal nodes has been emphasized by several authors,<sup>9,13,14</sup> although it was not a prominent feature in our series.

Clinically, these patients present the usual signs and symptoms associated with Hodgkin's disease. Irritative cough and shortness of breath are common, particularly in those individuals with generalized, massive involvement of the mediastinal lymph nodes. The roentgenologic manifestations are likewise not pathognomonic, for they may appear in many other lesions of the chest. The diagnosis depends on biopsy of peripheral nodes or other accessible material.

CASE I. J. I., white male, aged thirteen, complained of swelling of the neck, weight loss and headache. Large bilateral cervical nodes and a

palpable spleen were found on examination. The temperature curve ranged from 38° to 40° C. Biopsy of a cervical node established the diagnosis of Hodgkin's disease. For several months there was fair response to high voltage roentgen therapy, but the patient died four years after the onset of the disease. At autopsy (Dr. Paul Gross) the diagnosis was confirmed



FIG. 1. Case I. Mediastinal type. Large group of right hilar nodes.

by finding enlarged, discrete and firm lymph nodes in the mediastinum in the region of the main stem bronchi. The spleen was enormously enlarged (575 gm.) and diffusely infiltrated with nodular masses. Roentgenogram of the chest (Fig. 1) showed marked localized involvement of the right hilar nodes.

CASE II. J. S., white male, aged forty-seven, complained of hoarseness, cough, chest pain radiating to the right shoulder, fever and swelling of the neck. There was widening of the retrosternal dullness. Basal metabolic rate was plus 15. A tentative diagnosis of a substernal thyroid gland was made. However, a supraclavicular node measuring 5 mm. in diameter which was removed for biopsy proved to be early Hodgkin's disease. Radiation therapy caused retrogression of the involved nodes in the para-





FIG. 2. Case II. Mediastinal type. Paratracheal nodes enlarged bilaterally.

tracheal regions. The patient was progressing satisfactorily four years after the onset of the disease. Roentgenogram of the chest (Fig. 2) showed bilateral enlargement of the paratracheal nodes.

CASE III. J. B., white female, aged fifty-one, had swelling of the right side of the neck. Examination showed enlarged right supraclavicular lymph nodes with an increase in the retrosternal dullness. Biopsy of a node revealed Hodgkin's disease. There was marked retrogression following roentgen therapy. Fifteen months later the patient had a relapse with fever and enlargement of the liver and spleen. Three doses of 200 r were administered over the liver and spleen, but no further therapy was given due to the presence of a neutropenia. The patient died sixteen months after the onset of the disease from pyemia and agranulocytosis. Autopsy (Dr. A. E. Margulis) revealed hyalinization and fibrosis of the irradiated paratracheal nodes, and Hodgkin's disease of a celiac lymph node. Roentgenogram of the chest (Fig. 3) showed diffuse enlargement of the paratracheal and hilar nodes producing a massive mediastinal shadow.

## II. *Parenchymal Types*

Involvement of the lung parenchyma occurred in 40 per cent of the series and represents the second most common type. These patients are likely to present the most confusing diagnostic problems because of the wide variety of roentgenologic manifestations which can be produced. It is this type which so closely simulates tuberculosis, pneumonia, bronchogenic carcinoma, sarcoidosis, pulmonary abscess and pulmonary metastases. It must be emphasized that frequently no clear-cut distinction can be drawn between the various types of intrathoracic involvement which are described. Combinations occur commonly, particularly the association of pulmonary and pleural lesions with enlargement of the mediastinal nodes.

*Infiltrative lesions.* The lung may be involved in Hodgkin's disease in numerous ways. Frequently the pulmonary lesions are produced by direct infiltration of the lung from mediastinal nodes. This invasion oc-

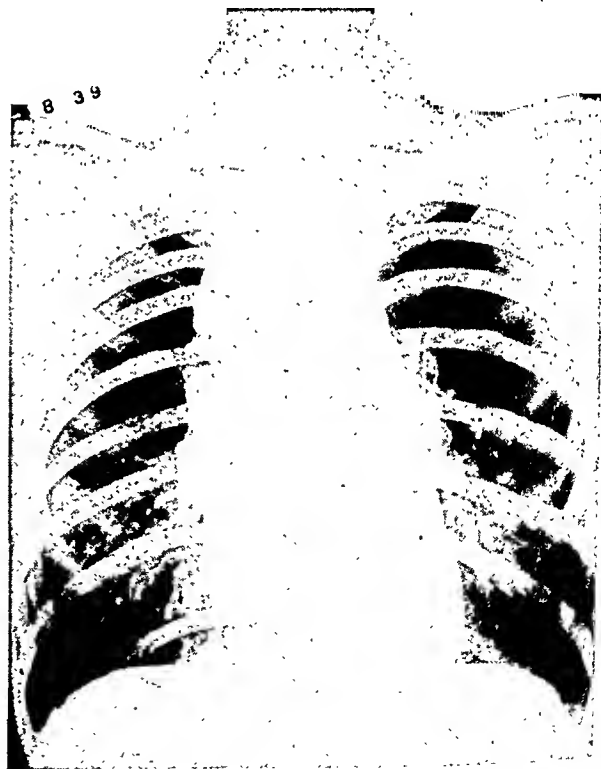


FIG. 3. Case III. Mediastinal type. Right paratracheal and hilar nodes, moderately enlarged.

curs as a solid growth which extends across the mediastinal pleura into the parenchyma to produce the picture of a massive tumor of the lung (Case v). These cases may be readily confused with bronchogenic carcinoma.

The lung itself contains an abundance of lymphoid aggregates. It has been shown<sup>10</sup> that follicles and small collections of lymphoid cells are present at points of bronchial branching, situated between the tunica muscularis and the accompanying artery. Similar collections are found at points of division of the pulmonary arteries, lying between the vessel wall and the adjacent alveoli. Lymphoid tissue is also found at points of junction of the pulmonary veins.

A frequent mode of extension is by infiltration of the disease along the peribronchial and perivascular lymphatics and lymphoid tissue, resulting in a granulomatous bronchitis and peribronchitis.<sup>11</sup> The bronchi appear encased in granulomatous tissue and may even be occluded. Roentgenologically, this type of extension reveals itself as linear or feathery infiltrations extending into the lung field from the hilum (Cases iv and vi).

Another infiltrative lesion occurs by extension of the disease through the alveoli, producing a granulomatous consolidation of the lung. This may be of lobar distribution resembling the appearance of a pneumonia (Case viii). However, it may be lobular in character, and, situated in the upper lobes, these small areas of involvement may closely resemble pulmonary tuberculosis (Case vii).

CASE IV. B. U., white female, aged twenty-seven, first entered the hospital in December, 1929, because of cervical node enlargement of one month's duration. Biopsy revealed the presence of Hodgkin's disease. Roentgen therapy caused clinical remission of the disease. In January, 1938, she developed cough and shortness of breath. Physical signs of infiltration of the left upper lobe developed. Further irradiation produced satisfactory remission. She then devel-

oped symptoms of cardiac failure which responded to roentgen therapy. However, later involvement of abdominal nodes occurred with progression of the disease and ultimate death in June, 1940, ten years and seven months after the onset of the disease. Autopsy (Dr. A. E. Margulis) showed involvement of the right lung, mediastinum, heart and spleen by Hodgkin's disease. Roentgenogram of the chest showed mediastinal enlargement with extension into the left lung (Fig. 4A), bilateral diffuse involvement (Fig. 4B), and retrogression of the lesions following roentgen therapy (Fig. 4C).

CASE V. A. H., white male, aged twenty-four, was admitted to the hospital because of cough, chills, chest pain, fever, diarrhea and pruritus. The cervical nodes were enlarged and the fever persisted. Biopsy of a cervical node revealed Hodgkin's disease. There was poor response to irradiation and the patient died eight months after admission. Roentgenogram of the chest (Fig. 5) showed massive mediastinal involvement with invasion of the right lung. The disease had extended from the nodes of the right hilum and paratracheal region into the parenchyma of the lung.

CASE VI. S. B., white male, aged thirty-five, was referred because of enlargement of the left supraclavicular lymph nodes. The diagnosis of Hodgkin's disease was made by biopsy. Parenchymal involvement developed which responded favorably to irradiation. There was clinical remission of the disease for several months, but the patient then followed a retrogressive course and death occurred two years after the onset of the disease. Roentgenograms of the chest (Fig. 6A) showed a linear infiltration radiating from the left hilum which retrogressed considerably after treatment (Fig. 6B).

CASE VII. A. R., white female, aged thirty, was admitted to the tuberculosis pavilion of the hospital because of cough and fever. Four years previously at another institution an enlarged cervical node had been removed and a diagnosis of Hodgkin's disease established. Roentgen therapy had also been administered at that time. During the present admission thorough examination showed no evidence of tuberculosis. Biopsy of another cervical node revealed Hodgkin's disease with irradiation changes. The patient responded poorly to irradiation and died seven months after admission. Autopsy (Dr.

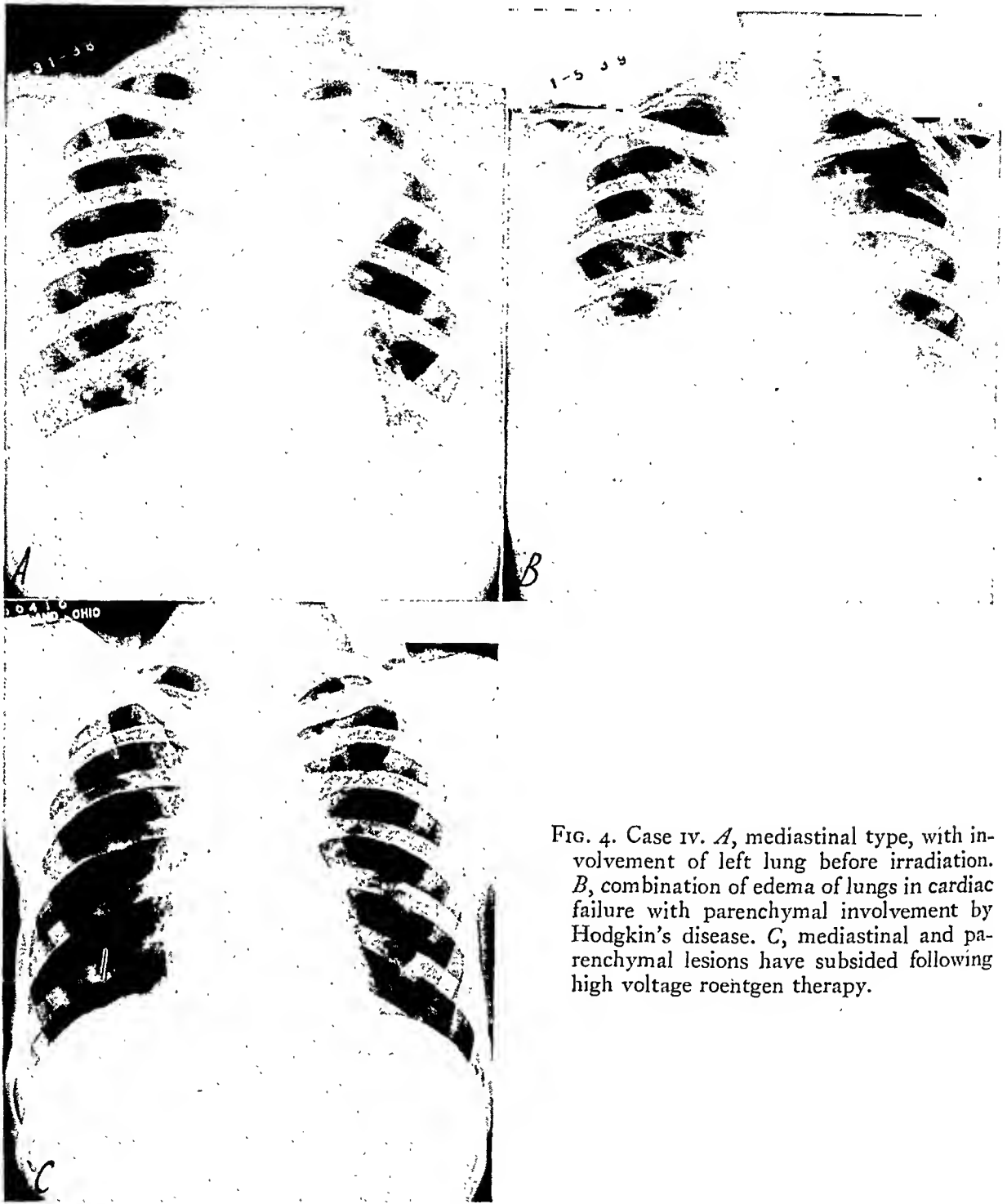


FIG. 4. Case IV. *A*, mediastinal type, with involvement of left lung before irradiation. *B*, combination of edema of lungs in cardiac failure with parenchymal involvement by Hodgkin's disease. *C*, mediastinal and parenchymal lesions have subsided following high voltage roentgen therapy.

R. P. Moore) revealed a spherical mass of Hodgkin's tissue 9 cm. in diameter extending from the right hilum to the upper, middle and lower lobes. Extensive fibrosis in the lesion was thought to represent irradiation changes. Roentgenograms of the chest (Fig. 7, *A* and *B*) showed diffuse parenchymal infiltration in the right middle and upper lung fields. The appearance of the latter could readily be confused with tuberculosis.

CASE VIII. E. B., white male, aged twenty-eight, was admitted to the hospital because of weight loss, pain in the left shoulder, fever and enlargement of the cervical lymph nodes. Biopsy showed Hodgkin's disease to be present. Roentgenograms of the chest (Fig. 8, *A* and *B*) showed dense mottling in the right lung field. The lateral view demonstrates a homogeneous density of the right middle lobe simulating pneumonic consolidation. Autopsy (Dr. C. M.

Blumenfeld) showed involvement of numerous organs including lung, pleura, diaphragm and mediastinal nodes. The right middle lobe was reduced in size, firm and infiltrated with pale gray to pale yellow masses.

*Nodular lesions.* A less frequent manifestation is the occurrence of well circumscribed, isolated nodules which closely simulate the roentgen appearance of pulmonary metastases. In our cases these isolated nodules were usually accompanied by other manifestations of Hodgkin's disease within the thorax, particularly involvement of the mediastinal nodes. It cannot be stated with certainty whether these circumscribed nodules arise as independent foci of Hodgkin's disease in pulmonary lymphoid aggregates or whether they are produced by extension of the disease along peribronchial and perivascular lymphatic channels.

In this series there have been no examples of the miliary lesions of the lungs such as that described by Vieta and Craver.<sup>12</sup>

CASE IX. E. S., white female, aged forty-five, was admitted to the tuberculosis service be-



FIG. 5. Case v. Massive mediastinal involvement with invasion of the lung. The disease has extended from the right hilum and paratracheal nodes to the right upper lobe.

cause of cough, expectoration, loss of weight and fever of ten months' duration. Later there



FIG. 6. Case vi. A, diffuse parenchymal infiltration radiating from the left hilum before irradiation. B, diffuse parenchymal involvement almost completely disappeared following treatment by high voltage roentgen rays.

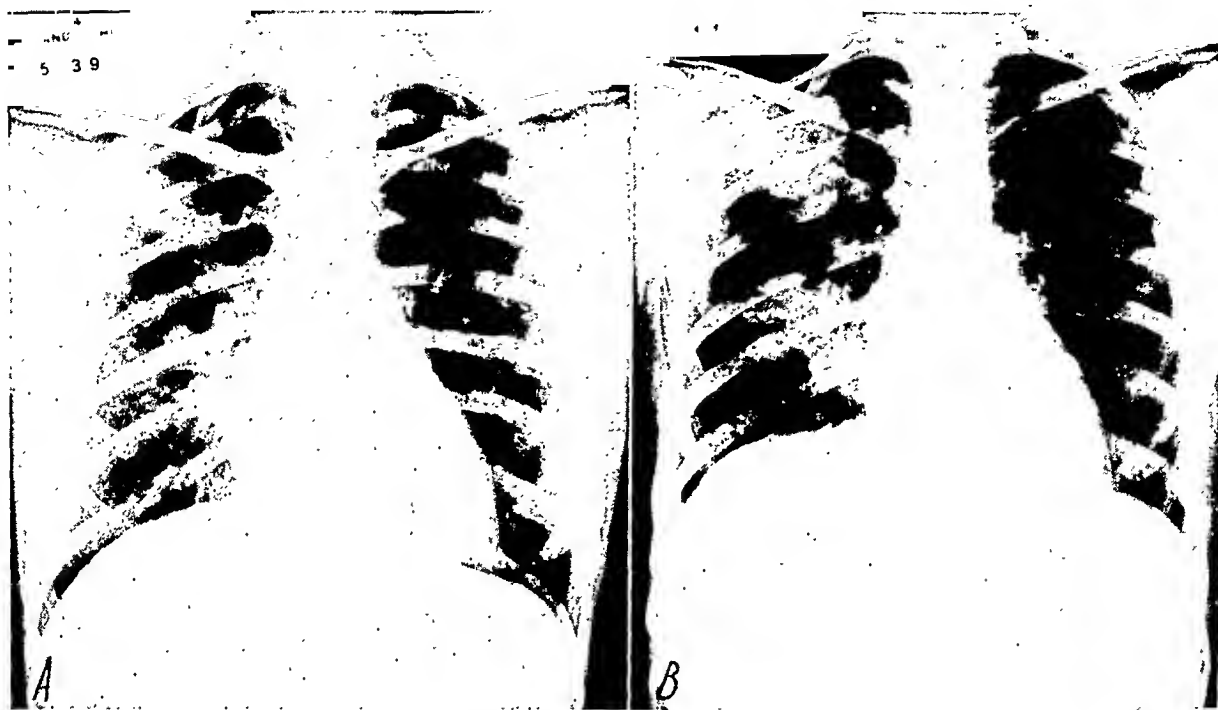


FIG. 7. Case VII. *A*, diffuse parenchymal infiltration in the right upper lobe. *B*, diffuse parenchymal infiltration, more extensive in the right lung. Unaffected by radiation therapy.

developed a serous effusion on the right which necessitated several thoracenteses. The sputum was constantly negative for tubercle bacilli. The

patient died three months after admission to the hospital. Autopsy (Dr. M. R. Oldt) revealed extensive Hodgkin's disease of the lungs,

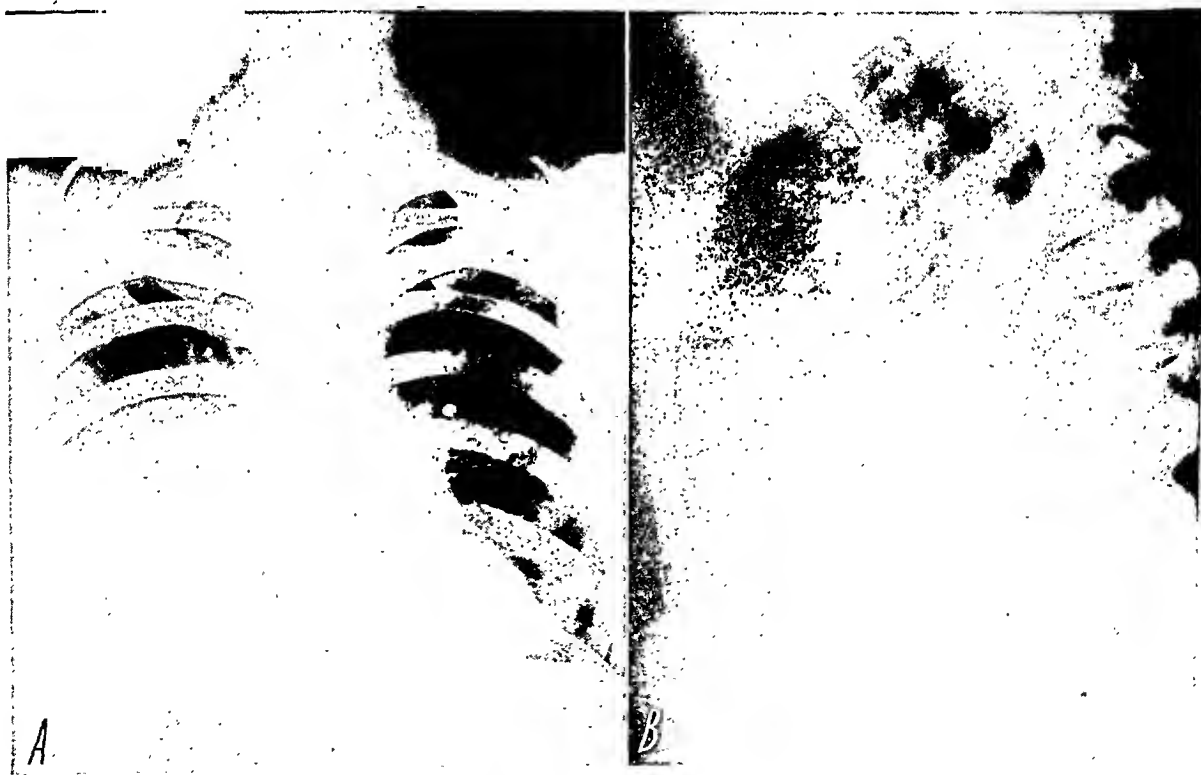


FIG. 8. Case VIII. *A*, lobar distribution of Hodgkin's infiltration in right lower lung field. *B*, lateral view reveals infiltration to be located in the right middle lobe.



FIG. 9. Case IX. *A*, nodular infiltration in right upper, left upper and left lower lobes. Pleural effusion present on right. *B*, specimen of right lung. Nodular and diffuse infiltration viewed from posterior aspect.

pleura, liver, spleen and mediastinal lymph nodes. Roentgen examination of the chest (Fig. 9*A*) showed nodular infiltration of both upper lobes and the left lower lobe. There was a pleural effusion on the right. The pathologic specimen (Fig. 9*B*) shows the character of the infiltration in the right lung.

CASE X. J. S., white female, aged twenty-eight, was admitted with the complaint of cough and fever. Biopsy of a cervical node revealed the presence of Hodgkin's disease. There was satisfactory remission of the disease until the patient became pregnant. She had a spontaneous delivery of a dead fetus at seven months. Following this mishap, there was poor response to treatment. Death occurred four years after the onset of the disease. Roentgenogram of the chest (Fig. 10) shows a large circumscribed nodular infiltration of the lower right lung field. The infiltration in the left lower lobe was somewhat more diffuse.

Certain other interesting parenchymal changes have been noted, such as atelectasis and cavitation.

*Atelectasis.* In addition to extension of Hodgkin's disease peribronchially, granulomatous ulcerations and plaques may oc-

cur within the bronchial wall,<sup>11</sup> or there may be actual invasion of the bronchus

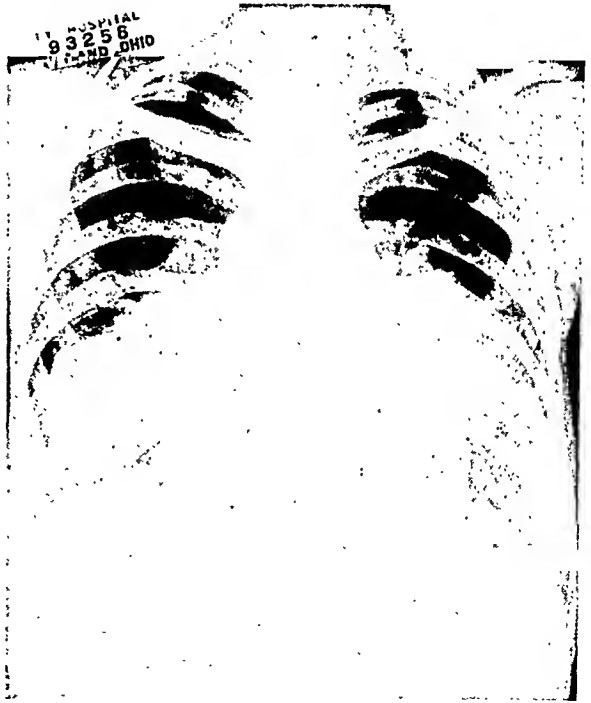


FIG. 10. Case X. Nodular infiltration of large size in right lower lung. The lesion was unaffected by irradiation.

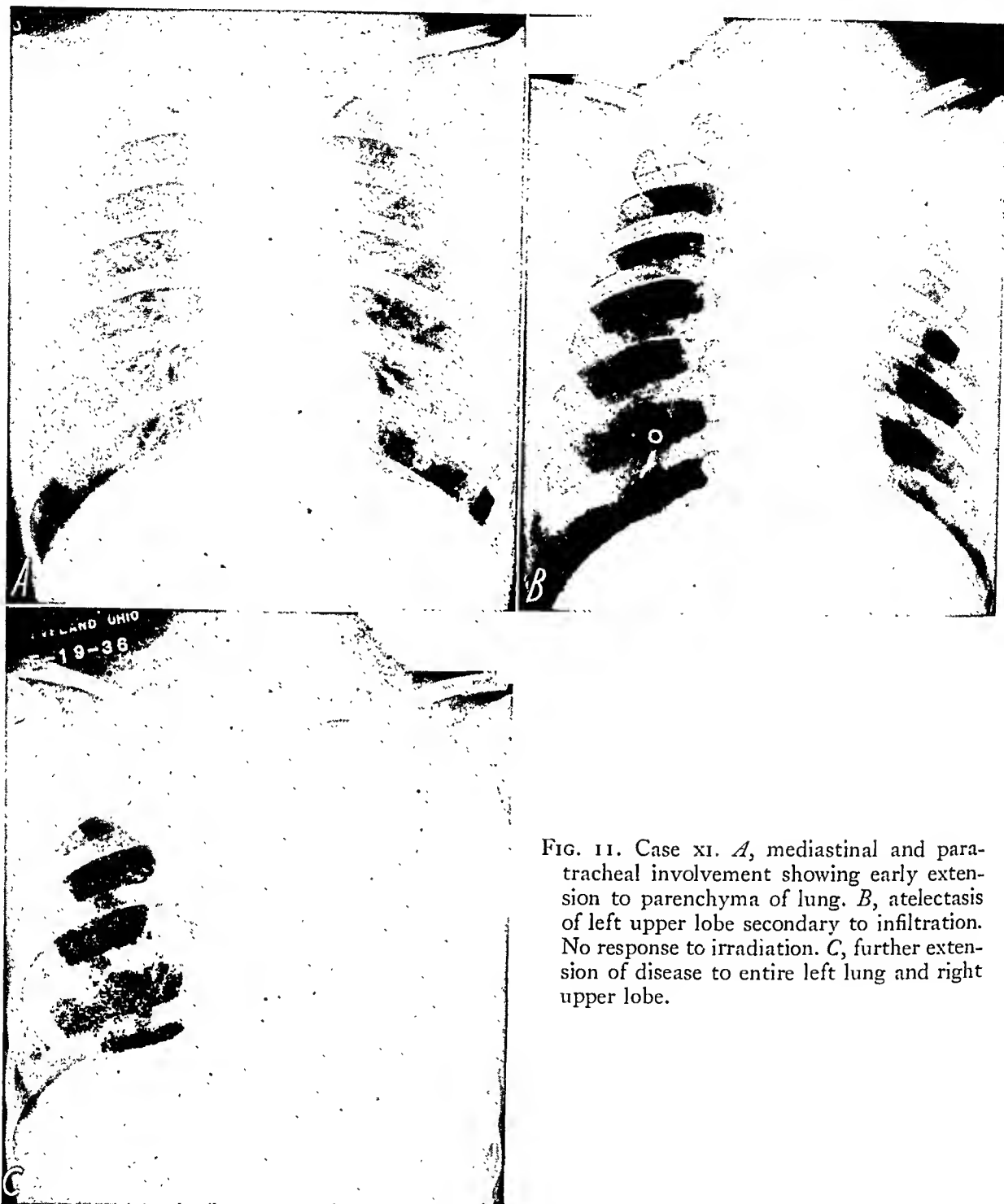


FIG. 11. Case XI. *A*, mediastinal and paratracheal involvement showing early extension to parenchyma of lung. *B*, atelectasis of left upper lobe secondary to infiltration. No response to irradiation. *C*, further extension of disease to entire left lung and right upper lobe.

from adjacent diseased lymph nodes. In such instances bronchial obstruction and atelectasis may occasionally be produced, simulating the appearance of bronchogenic carcinoma.<sup>4,11</sup> This change is usually a gradual process so that the extent of the collapse may be progressive (Fig. 11, *A*, *B* and *C*). In a few instances, bronchoscopic

biopsy has established the diagnosis of Hodgkin's disease.<sup>7,12</sup>

CASE XI. J. O., female, aged twenty-four, nurse, was admitted to the hospital because of loss of weight, fever and malaise. Biopsy of a small cervical lymph node revealed only a chronic granulomatous infiltration. However, a presumptive diagnosis of lymphoma was made



and the patient was given roentgen therapy. There was no improvement and she died one year after the onset of the disease. Roentgenograms of the chest (Fig. 11A) showed mediastinal and paratracheal involvement on the left. Later there was atelectasis of the left upper lobe (Fig. 11B) followed by extension to the entire left lung and consolidation of the right upper lobe (Fig. 11C). Autopsy (Dr. H. H. Heitzman) revealed extensive Hodgkin's involvement of the lungs, pleura and mediastinal nodes. There was granulomatous tissue in the left main-stem bronchus and in the right hilum which resulted in bronchial obstruction and atelectasis of the left lung and right upper lobe.

**Cavitation.** Cavitation occurs as a result of necrosis of Hodgkin's tissue within the lung and its extrusion through the tracheobronchial tree. In these instances microscopic examination shows the cavity wall to be lined by granulomatous tissue. This is an uncommon manifestation of intrathoracic Hodgkin's disease which may be confused particularly with tuberculosis, abscess and cavitary bronchogenic carcinoma. Examples have been described by Hardin,<sup>4</sup> Bouslog and Wasson,<sup>1</sup> and Vieta and Craver.<sup>12</sup>

**CASE XII.** S. W., white female, aged sixty, entered the hospital because of weight loss of two years' duration. She had previously been considered to have either tuberculosis or carcinoma of the lung. Roentgenogram of the chest (Fig. 12) showed parenchymal infiltration of the right upper lobe with multilocular cavitation. Autopsy (Dr. F. M. Rueggsegger) revealed Hodgkin's disease of the right lung and mediastinal lymph nodes. The lesion of the right upper lobe was cavitated and the cavity wall microscopically contained granulomatous tissue.

Clinically, patients with parenchymal involvement present all the signs and symptoms usually associated with the more common pulmonary diseases. Cough, chest pain, fever, weight loss and night sweats are common. In the cavitary forms, purulent expectoration may occur. Hemoptysis is an interesting but uncommon complication. Usually it results from erosion of the bronchial mucosa but may likewise occur in the cavitary forms. The presence of such

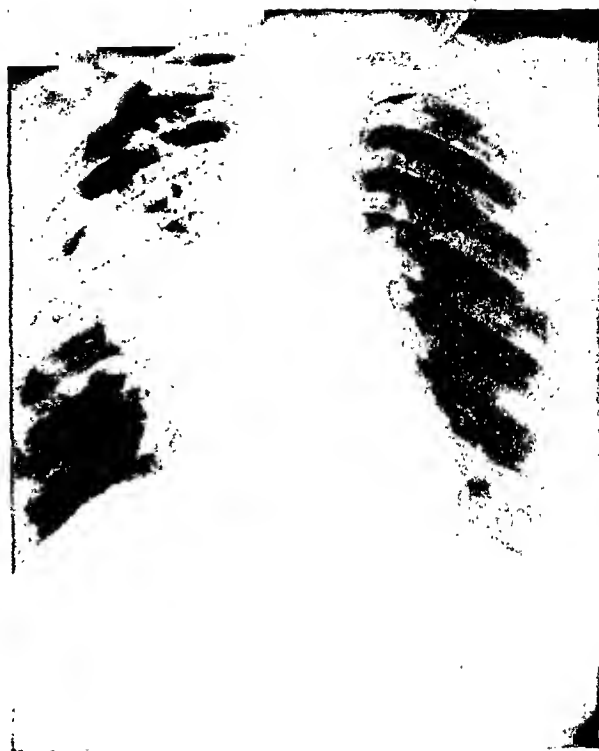


FIG. 12. Case XII. Parenchymal involvement with multilocular cavitation in right upper lobe.

symptoms may result in diagnostic difficulties. Biopsy of accessible material, however, will usually clarify the problem.

### III. Pleural Type

The pleura contains many small foci of lymphoid cells but no follicles or nodes. Similar lymphoid collections are found in the connective tissue septa separating the secondary lobules. Pleural involvement in Hodgkin's disease is frequent, occurring as nodular or infiltrating masses on the pleural surface. These lesions may produce massive and persistent effusions which can be confused with those of tuberculosis and of carcinoma. The effusions are usually serous in nature although chylous and sanguineous effusions may occur. Pleural effusions may be present in the absence of direct involvement of the pleural surface through pressure by enlarged mediastinal lymph nodes on lymphatic and blood vessels at the hilum.

**CASE XIII.** M. H., white female, aged fifty-two, was admitted because of stiffness and

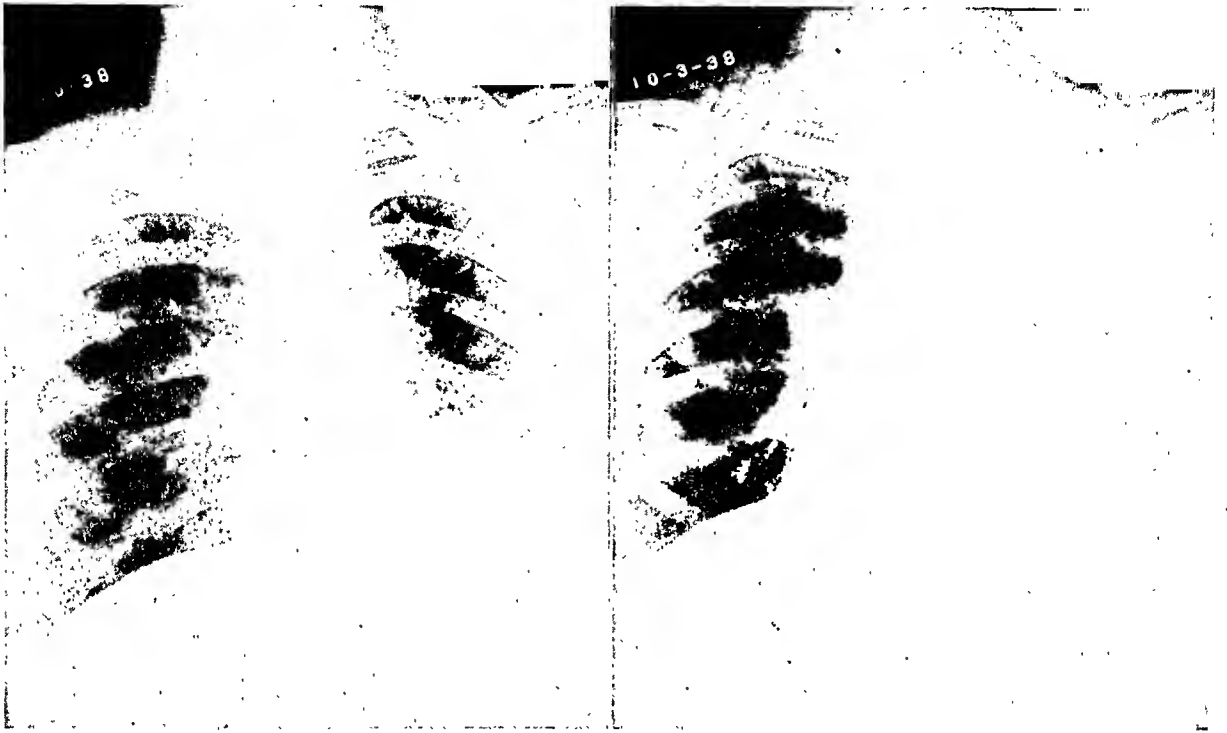


FIG. 13. Case XIII. *A*, pleural involvement in left lower chest. Left hilar nodes involved. *B*, extension of pleural involvement with massive effusion.

swelling of the neck, weight loss of three months' duration, and a sensation of fullness in the throat. Biopsy of a cervical node revealed

Hodgkin's disease. The patient showed immediate response to high voltage roentgen therapy, but later died suddenly of pulmonary embolism. Roentgenogram of the chest (Fig. 13*A*) showed early pleural involvement with a small pleural effusion. Later a massive left pleural effusion developed (Fig. 13*B*).



FIG. 14. Case XIV. Extensive right pleural effusion with nodular infiltration in both lungs.

CASE XIV. R. K., white male, aged seventeen, was admitted because of enlarged nodes in the left axilla and small nodules in the skin of the right chest wall. Biopsy of the skin lesions showed Hodgkin's disease. Pain developed in the right chest. Later there was cough and shortness of breath. Straw colored serous fluid was aspirated from the right pleural space. There was poor response to irradiation and the patient died one year after the onset of the disease. Roentgenogram of the chest (Fig. 14) showed an extensive right pleural effusion with nodular lesions in both lungs. Autopsy (Dr. E. B. Helwig) revealed generalized Hodgkin's sarcoma. The right and left pleural cavities contained 3,000 cc. and 1,000 cc. of yellow serous fluid respectively. Numerous irregular and somewhat nodular elevated areas measuring from 1 to 4 cm. in diameter were found on the visceral pleurae.

#### IV. Osseous Type

The ribs, sternum and other bony structures may be involved by direct extension of the disease from underlying lymph nodes or granulomatous lung or pleura. Occasionally the process may start in the ribs or sternum and invade the lung.

CASE XV. B. R., white male, aged seventeen, was admitted because of generalized pruritus of

from adjacent structures, particularly the mediastinal lymph nodes. If involved, objective evidence consists of changes in rhythm, the configuration of the heart, and evidences of myocardial insufficiency which may retrogress after therapy. The presence of such evidence during the course of Hodgkin's disease should suggest extension of the process to the heart.

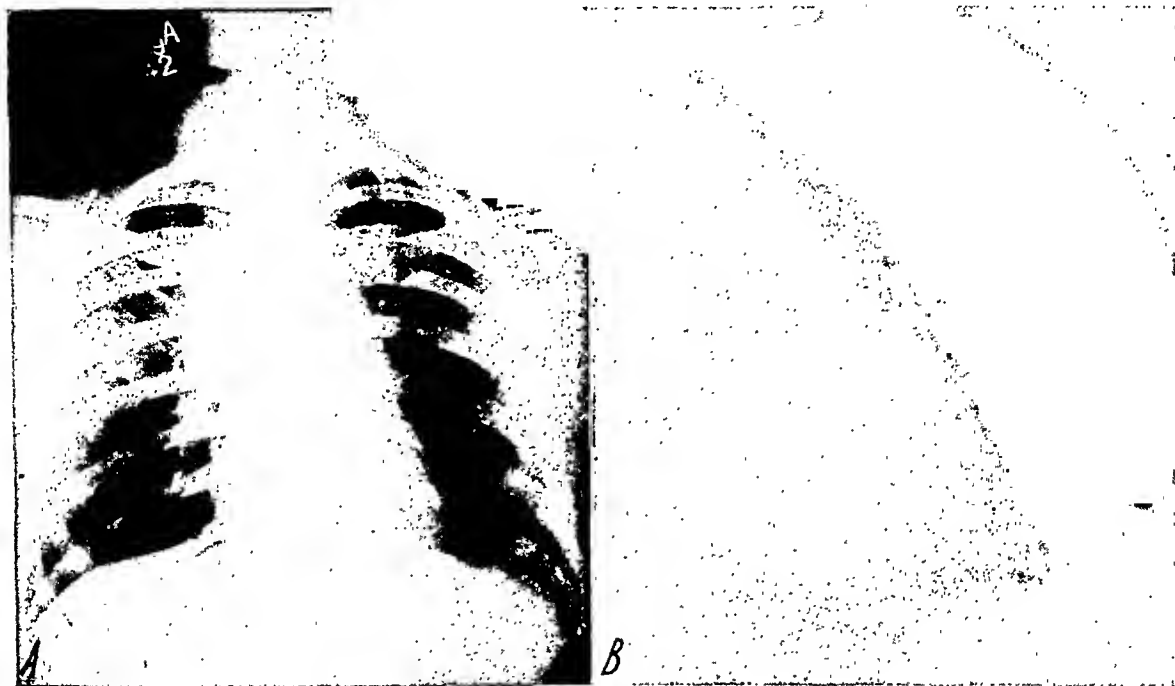


FIG. 15. Case xv. *A*, large upper right mediastinal mass extending anteriorly to involve manubrium sterni. *B*, lateral view of sternum showing destructive process in the manubrium.

three months' duration. He had also observed swelling of the upper anterior chest wall during this period. Examination disclosed a mass 7.5 cm. in diameter located in the midline at the level of the junction of the first rib with the sternum. There was no enlargement of the peripheral lymph nodes, liver or spleen. Biopsy of this mass showed the sarcomatous form of Hodgkin's disease. Roentgenograms of the chest and sternum (Fig. 15, *A* and *B*) showed a large mass in the upper right mediastinal region extending anteriorly and causing destruction of the manubrium sterni.

#### V. Cardiac Type

The heart is rarely affected in Hodgkin's disease, but may be involved by extension

CASE IV. B. U., white female, aged twenty-seven, was previously described in this communication. This case was reported in detail by Garvin.<sup>3</sup> In 1938, eight years after the onset of her disease she developed dyspnea on exertion. Roentgenograms of the chest showed an enlargement of the cardiac shadow in its transverse diameter to 16.5 cm. as compared with a previous measurement of 11 cm. Following irradiation to the anterior mediastinum this dimension was reduced to 14 cm. and clinical improvement followed.

One year later she developed congestive cardiac failure with edema, enlargement of the liver and râles at the lung bases. The blood pressure was 100/70. Electrocardiogram showed an inverted T<sub>2</sub>, low voltage of T and QRS waves

in all leads, and auricular fibrillation. Roentgen therapy to the mediastinum was again administered, as well as digitalis and mercurial diuretics. Marked clinical improvement ensued. The rhythm became normal and the congestive failure disappeared.

She responded well for several months, but returned in June, 1940, with general progression of the disease. She died eighteen months after onset of the cardiac decompensation, and ten years and seven months after the onset of the disease.

At autopsy (Dr. A. E. Margulis), the aorta, the pulmonary arteries, the great veins and the atria were encased in a dense mass of Hodgkin's tissue. The granulomatous tissue invaded the walls of both atria and extended directly into the atrial cavity. The pericardial space was obliterated. Both lungs contained Hodgkin's disease, more particularly the right, the disease extending secondarily from the mediastinum. There was also involvement of the liver, spleen and adrenal glands.

#### ROENTGEN THERAPY

Just as roentgen rays have long proved of value in the treatment of Hodgkin's disease of peripheral involvement, radiation therapy has also been useful in the management of Hodgkin's lesions located elsewhere in the body, particularly those involving the thorax. It has been known for many years that the response of mediastinal tumors to small doses of radiation has constituted a differential diagnostic test between the lymphoblastoma group and lesions of different nature. As experience demonstrated the great regularity of retrogressions of mediastinal nodes following the application of roentgen rays, attempts were made by many workers to produce similar results on Hodgkin's lesions involving the thorax. These investigations have been justified, since the results have shown that, while retrogressions cannot be obtained with the same degree of regularity as in the treatment of peripheral lymph node involvement, symptoms in many patients have been relieved and in others the duration of life has been prolonged to a considerable degree. General medical therapy, in con-

junction with radiotherapy, is essential if the best results are to be obtained.

Twenty-three of the 35 cases were treated by irradiation. Seventeen cases considered adequately irradiated showed definite favorable response of varying degrees. Three patients with adequate and 2 patients with inadequate dosage showed no favorable response, and in 1 case there was no record of the result of treatment.

Because of the high incidence of involvement of the lymphatic chains of the mediastinum and abdomen found at autopsy, it has become routine in many clinics<sup>6,8</sup> to irradiate these regions in all cases of Hodgkin's disease even though the lesions are not demonstrable by clinical or roentgenological examinations. Jacox, Peirce and Hildreth<sup>8</sup> reported a greater survival rate in those patients who received systemic irradiation to abdominal and mediastinal nodes than in patients who received treatment only to the peripherally involved regions. When the disease is known to exist in the mediastinal and abdominal lymph nodes, larger total doses of roentgen rays are applied to these regions to assure a more certain therapeutic effect.

No definite rules or formulae can be laid down for determining the exact dosage to be applied to all patients, since the irradiation response of lesions varies considerably in different subjects. Instances in our own series range from cases with an extremely high degree of radiosensitivity to only one or two small doses to those which failed to respond in the least to relatively large quantities of roentgen rays. Conventional high voltage apparatus has been employed. The technical factors used were 200 kilovolts, 20 milliamperes, 50, 60 and 70 centimeter target-skin distance and 0.75 mm. Cu plus 2.0 mm. Al filtration (half-value layer of 0.9 mm. Cu). The output in roentgens varied from 35 to 17.5 per minute. The size of the fields ranged from approximately 50 to 150 square centimeters.

In general, for the treatment of mediastinal lymph nodes, it may be stated that 200

r (measured in air) should constitute the average daily dose applied to a lesion and the total dosage over a period of days or weeks should depend upon the response to irradiation from the standpoint of both constitutional and local reactions. The latter can be gauged clinically and by frequent roentgenoscopic or roentgenographic investigations. Some patients may show complete disappearance of their lesions after a few days of treatment while others may require total dosages of 2,000 to 3,000 r directed toward each region involved. For pulmonary lesions, the course may vary from a few daily doses of 300 to 400 r to a longer series of daily doses of 100 r over the affected region utilizing a cross-fire technique of anterior, posterior and lateral fields where possible. The total dosage to each field in the latter procedure should be at least 1,000 r. Good temporary retrogressions have been observed in 2 cases treated through anterior and posterior fields without the occurrence of undue irradiation sickness.

Single massive doses (500 to 600 r) are avoided because of undesirable constitutional effects and greater damage to normal tissues which might require more treatment at a later date should recurrence take place. However, Craver<sup>2</sup> states, in referring to Hodgkin's disease in general, that fewer, but larger single doses have proved to be of as much benefit, if not more, than divided doses administered in larger total quantities. It is evident from a review of the literature that no consensus has been arrived at regarding dosage technique.

#### SUMMARY

Of 55 proved cases of Hodgkin's disease in which chest roentgenograms were available, 35, or 63 per cent, showed intrathoracic involvement. The varied manifestations of intrathoracic Hodgkin's disease were correlated with the distribution of lymphoid tissue within the chest. Mediastinal, parenchymal, pleural, osseous and cardiac

types were described and illustrated by 15 case reports.

Roentgen therapy was discussed and it was concluded that the majority of patients with intrathoracic Hodgkin's disease will show definite but varying degrees of favorable response to roentgen treatment.

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# SOME ROENTGENOLOGICAL AND PATHOLOGICAL ASPECTS OF CALCIFICATION OF THE CHOROID PLEXUS\*

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A REVIEW of some of the established facts regarding the histopathological changes which result in choroid plexus calcification has been undertaken with the hope that we might be better able to evaluate the significance of the shadows cast in the roentgenogram and to appraise their value in the diagnosis of expanding intracranial lesions. Our interest in this subject has been aroused by several cases of aberrant choroid plexus calcification and the problems introduced in deciding their importance. Two cases of choroid plexus calcification occurring at ages earlier than any yet reported were encountered.

## HISTORICAL

Herophilus and his associates were probably the first investigators to gain substantial knowledge of the human choroid plexuses, as a result of anatomical studies at the ancient University in Alexandria. From Galen<sup>26</sup> we learn that Herophilus investigated the minor tortuosities of the cerebral meninges, to which he applied the appropriate name chorioid (chorion-like) because of their resemblance to the fetal membranes. Galen,<sup>27</sup> himself, was impressed by their resemblance to this fetal structure.

## ANATOMICAL DISCUSSION

The development of the choroid plexuses of the lateral ventricles in the human embryo has been traced by Bailey<sup>2</sup> from an area in the lateral roof plate of the telencephalon. The tela choroidea superior and tela choroidea inferior arise through a mesenchymal overgrowth and vascularization of the roof plates of the third and fourth ventricles. Here the choroid plexuses

are formed by an invagination of the roof epithelium by the development of plexus tissue in the overlying pia-arachnoid.

In the fully developed brain the choroid plexuses of the lateral ventricles are highly vascular folds of pia-arachnoid which project into the ventricular cavities. They extend from the ends of the temporal horns to unite at the interventricular foramina described by Monro<sup>40</sup> through which they pass into the tela choroidea of the third ventricle. Here the plexuses continue as a pair of narrow paramedian bands of plexus tissue extending from the interventricular foramina to the suprapineal recess. Two highly vascular invaginations of the tela choroidea inferior constitute the choroid plexuses of the fourth ventricle. The horizontal portions of each are joined to form a continuous band extending from one lateral recess to the other, while the vertical portions branch at right angles from the horizontal and extend toward the obex on each side of the midline.

The choroid plexuses are covered by a simple layer of cuboidal ependymal cells which everywhere separates the mesenchymal elements from the ventricular cavities. Beneath the villi the stroma is composed of delicate white fibrous tissue which is gathered together into bundles or trabeculae which form a network with numerous spaces of all shapes. These spaces are lined throughout by a single layer of flattened cells. The choroid plexus in the atrium of each lateral ventricle is expanded to form a fusiform swelling known as the glomus. This expansion is brought about to a large extent by an increase in number and size of the pia-arachnoid cavities, somewhat analogous to the subarachnoid cisterns.

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The function of the choroid plexuses is the production of the cerebrospinal fluid contained in the ventricles of the brain. The evidence for this belief has been reviewed by Weed.<sup>59</sup> There is fairly general agreement that under normal conditions the choroid plexuses have no resorptive function. The findings of Foley<sup>24</sup> and Hassin<sup>29</sup> led them to believe that under certain circumstances they could assume such a function. The work of Wislocki and Putnam<sup>61</sup> and of Dandy and Blackfan,<sup>13</sup> however, discredits this opinion.

#### PATHOLOGICAL PROCESSES IN THE CHOROID PLEXUSES

It has been pointed out by Beals<sup>3</sup> how few pathological processes, aside from tumors, have been ascribed to the choroid plexuses. The experiences of Cushing<sup>11</sup> and Davis and Cushing,<sup>14</sup> Elsberg,<sup>20</sup> Tooth,<sup>54</sup> Liber and Lisa,<sup>35</sup> and others, show that even tumors of choroid plexus origin are uncommon. Gamgee,<sup>28</sup> Ziegler,<sup>63</sup> and Manlove and McLean<sup>39</sup> described the occurrence of cholesteatomas of the choroid plexuses in horses and in man.

The formation of cysts and psammoma bodies in the choroid plexuses are generally considered to be regressive changes of such common occurrence that they are of negligible pathological significance. According to Findlay,<sup>23</sup> Hooper<sup>31</sup> first described the cystic changes. They were beautifully illustrated in colored drawings by Luschka.<sup>38</sup>

Psammoma bodies occur in all of the membranes of the brain and spinal cord and are also commonly present in tumors arising in these membranes. Some of the earliest descriptions of these bodies were given by Hooper,<sup>31</sup> Bergmann,<sup>4</sup> and Remak,<sup>45</sup> although Bergmann stated that they were known before this time. The calcified bodies have been variously named psammoma bodies, corpora arenacea, corpora amylacea, calcospherites, concentric concretions, acervulus cerebri, brain sand and sabulous bodies. Virchow<sup>57</sup> attempted to differentiate by iodine staining between the corpora amylacea which are commonly

found in the brain substance and the calcified structures of the choroid plexuses and meninges which he called psammoma bodies. This differentiation subsequently has been extended as it has been shown by Lafora,<sup>34</sup> Ferraro and Damon,<sup>21</sup> and others, that the corpora amylacea of the brain are probably of microglial or oligodendroglial



FIG. 1. Psammoma bodies in the connective tissue stroma of a choroid plexus of a fifty-six year old man. The usual concentric lamination of the bodies is shown. Two conjoined masses are shown in the lower left corner. (Hematoxylin and eosin stain  $\times 320$ .)

origin while the psammoma bodies are formed quite differently.

Von Zalka<sup>62</sup> and Biondi<sup>5</sup> have shown that the changes of deterioration which occur in the choroid plexuses are found with considerable frequency after the age of forty, generally corresponding to the age of onset of regressive brain changes as shown by Boyd.<sup>6</sup> The calcified bodies occur in all regions of the plexuses in the stroma or pia-arachnoid portion (Fig. 1). They vary greatly in number and size and according to Karsner<sup>33</sup> they may measure up to 3 mm. in diameter. For the most part they appear as rounded bodies made up of concentric rings. Conjoined or aggregated masses of such bodies are frequently found enclosed in a single fibrous envelope. It is thought by many that the ground substance of the corpora arenacea or psammoma bodies is a structureless matrix in which calcium salts



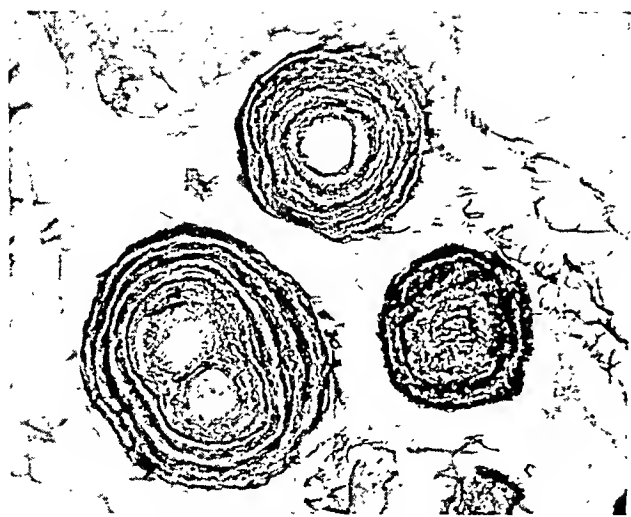


FIG. 2. The framework of the psammoma bodies is shown to be composed of dense collagen and argyrophilic reticular fibers in which calcium salts become deposited. Some of the fibers are arranged in dense concentric layers while others run irregularly in all directions. (Laidlaw's silver stain  $\times 400$ .)

become deposited and some authors have described them as structureless aside from concentric markings. Silver stains, however, show that even the well calcified psammoma bodies have an intricate framework of closely packed fibrous reticulum (Fig. 2).

The mechanism of formation of psammoma bodies has long been a subject of debate. Virchow<sup>58</sup> was convinced that the bodies originated chiefly through a proliferation and stratification of cells within

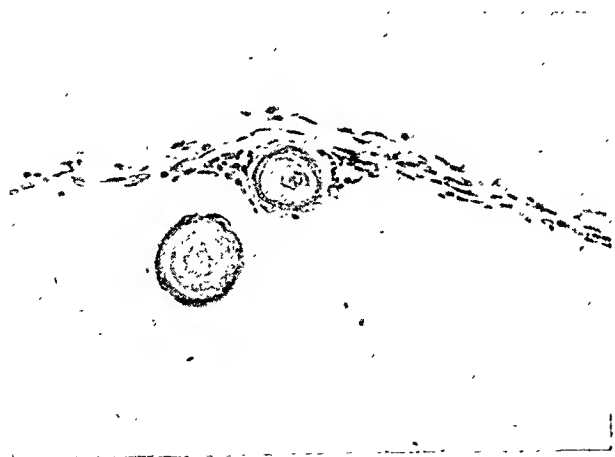


FIG. 3. A concentric body has formed in the wall of a small cyst of a choroid plexus. Another lies free in the cyst. (Hematoxylin and eosin stain  $\times 470$ .)

the connective tissue of the plexuses which became the seat of a process of petrification. The thorough studies of Findlay<sup>22,23</sup> led him to a rather similar conclusion. Cushing and Weed<sup>12</sup> studied the calcareous deposits of the arachnoid and found that calcification starts in the nuclei of the degenerating groups of cells at an early stage of the process. Rokitsky,<sup>46</sup> Findlay,<sup>23</sup> and von Zalka<sup>62</sup> showed that many of the calcifications may arise in cysts of the plexuses (Fig. 3). Taft<sup>53</sup> and others believed that the underlying pathological process is a fibrous obliteration of the vessels of the villous tufts, with resultant hyaline changes in the tips of the tufts or the formation of

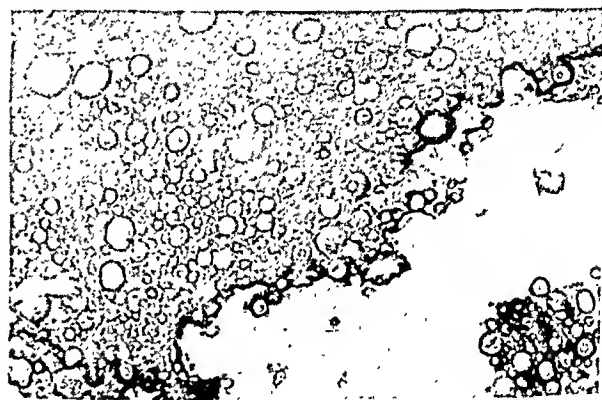


FIG. 4. Myriads of tiny concentric bodies are shown entering into the formation of a calcium mass which grossly appeared as a small fleck of calcium 1.5 mm. in length and 0.5 mm. in diameter. This formed part of the choroid calcification found in Case v. (Hematoxylin and eosin stain  $\times 400$ .)

cysts, while Cornil and Ranvier,<sup>10</sup> Findlay,<sup>23</sup> and Biondi<sup>5</sup> believed that the choroid calcification may sometimes arise in the vascular segments themselves.

The formation of bone in the choroid plexuses has been described by Findlay<sup>23</sup> and Sachs and Whitney.<sup>48</sup> Wells<sup>60</sup> and Asami and Dock<sup>1</sup> have pointed out that any area of calcification is likely to be replaced by bone, regardless of the tissue involved, through a stimulation of connective tissue to form bone. For the most part it appears that the congregation of multitudes of psammoma bodies in the expanded glomus to form a conglomerate calcium

mass accounts for the shadows most commonly cast in the roentgenograms as in Case v (Fig. 4).

#### ROENTGENOGRAPHIC DEMONSTRATION OF CHOROID PLEXUS CALCIFICATION

Schüller<sup>49</sup> was the first to mention the roentgenographic demonstration of choroid plexus calcification. Heuer and Dandy,<sup>30</sup> Ström<sup>52</sup> and O'Sullivan<sup>43</sup> later described similar calcification and pointed out its bilateral occurrence. Camp<sup>7,8</sup> has emphasized the importance of recognizing choroid plexus calcification and differentiating it



FIG. 5. Punctate calcium shadows in the choroid plexuses which have been described as resembling a collection of tiny glass beads.

from a displaced calcified pineal gland or a tumor. The work of Dyke, Davidoff and Elsberg<sup>18,19</sup> has enabled us to recognize the choroid plexuses by encephalography and ventriculography in a large percentage of cases and to localize calcium shadows in them with a high degree of certainty.

The incidence of choroid calcification recognizable by roentgen examination has been variously given. In a large series Dyke<sup>15</sup> found that 5.1 per cent showed choroid calcification. Childe<sup>9</sup> reported that 11.2 per cent of 1,000 cases showed calcification of the choroid plexuses while Schwartz<sup>50</sup> described a 13 per cent incidence. The percentage found is greatly increased if cases below twenty years of age



FIG. 6. Bilateral calcification in the glomera of the choroid plexuses of the lateral ventricles of the form which has been likened to a popped kernel of corn.

are excluded. Beals<sup>3</sup> found that 28 per cent of a group over twenty years of age showed such calcification.

The calcification may assume different forms on the roentgenograms. A common form is a collection of punctate shadows which Camp<sup>8</sup> likened to a cluster of tiny glass beads (Fig. 5). Dyke and Davidoff<sup>18</sup> described forms which they thought resembled a popped kernel of corn (Fig. 6). In other cases the shadows appear linear and crescentic (Fig. 14). In many instances they are a combination of several forms or appear as irregular amorphous solid masses of calcium.

Most authors have emphasized the symmetry of the calcification occurring in the plexuses. Beals,<sup>3</sup> Lowman and von Storch,<sup>37</sup> Vastine,<sup>55</sup> and others, have stated that the two shadows of the calcified choroid glomera and the pineal shadow can be considered as being located at the angles of an isosceles triangle formed by drawing lines between these shadows on the anteroposterior or posteroanterior skull roentgenogram. Although the calcification is usually fairly symmetrical it may vary considerably in extent and density on the two sides. Jacobsson<sup>32</sup> has pointed out the importance



FIG. 7. Asymmetrical calcification of the choroid plexuses. The roentgenograms were made in the course of study of a case of thyroid disease. (Same case as Figure 6.)

of recognizing that an asymmetrical distribution of calcium is encountered in some cases (Fig. 7). Calcification may even be unilateral. The position of the glomera may vary due to atrophy or hypoplasia of one cerebral hemisphere. Since psammoma bodies can occur in all portions of the plexuses it is reasonable to assume that occasionally they may attain sizable proportions elsewhere than in the glomera.

#### CHOROID PLEXUS CALCIFICATION IN CHILDREN

Calcification of the choroid plexuses may occasionally occur at an early age. Rothstein<sup>47</sup> described such calcification in a child four years of age. The following two cases illustrate calcification of the choroid plexuses in still younger children and in unusual locations.

CASE I (N.I. No. 18326). F. R., male, aged two and a half years. The patient was admitted December 18, 1933, because of convulsions which began at the age of ten months, and which were of increasing frequency. He was born after a prolonged labor but appeared to develop normally until the age of ten months. At this time he began to have convulsions and de-

veloped a left hemiplegia. Development was markedly retarded. The child was unable to sit, walk or talk and was apathetic to his surroundings. Blood examination disclosed a slight hypochromic anemia.

Roentgen examination of the skull showed no evidence of increased intracranial pressure. There was calcification in the glomus of the choroid plexus of each lateral ventricle and a calcium shadow, just to the right of the midline, was projected through the region of the pterion. Encephalograms revealed a generalized enlargement of the ventricular system and verified the presence of calcification in the choroid glomera. The anterior calcium shadow appeared to be in the anterior pattern of the plexus tissue near the interventricular foramina.

The diagnosis of cerebral spastic infantile paralysis was made clinically. The patient's behavior was that of an idiot and he was unimproved during his stay in the hospital.

CASE II (N. I. No. 14030). B. B., female, aged three years. The child was admitted October 18, 1943, because of convulsions beginning at the age of three months, and retarded development. She was born following a normal term delivery. On admission the child was found to be mentally deficient and unable to talk. There was generalized muscular hypotonicity and an ataxia.

Encephalograms showed the lateral and fourth ventricles to be normal in shape and position but slightly enlarged. The cisternae

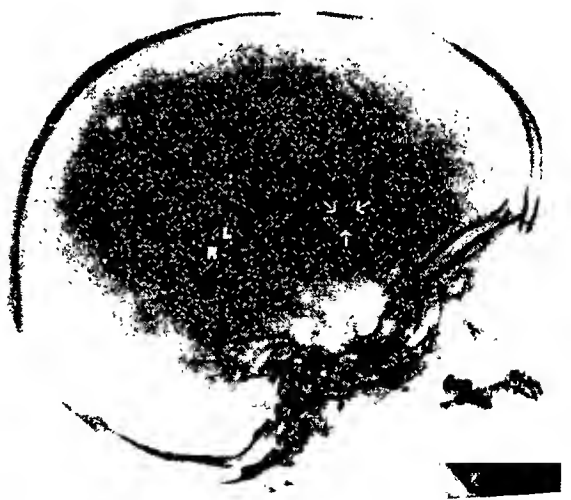


FIG. 8. Case I. Bilateral calcification in the glomera of the choroid plexuses of a child, aged two and a half, with calcification in the region of the interventricular foramina.

pontis and magna were also rather large. Several calcified masses were present in the choroid plexuses of the lateral ventricles. One shadow was just to the left of the midline at the interventricular foramina, one was in the mid-portion of the body of the right lateral ventricle and one was present in each glomus.

A diagnosis of cerebral and cerebellar aplasia was made. The patient's course was stationary during her hospital stay and she was discharged to enter a sanatorium for permanent institutional care.

*Discussion.* Case I (Fig. 8 and 9) and Case II (Fig. 10) illustrate aberrant calcification in the choroid plexuses of very young children. In one instance calcification was present in the choroid plexus in the body of a lateral ventricle while in both cases calcification occurred in the choroid glomera and at the interventricular foramina.

#### CALCIFICATION IN THE REGION OF THE FOURTH VENTRICLE

Calcification of the choroid plexuses of the fourth ventricle has not been described in the literature to our knowledge. Jacobson<sup>32</sup> was also unable to find a report of such a case. In the following instance calcification was found in the posterior fossa in the region of the fourth ventricle.



FIG. 10. Case II. Encephalogram of a child, aged three, showing bilateral calcification in the choroid glomera. There are rounded shadows of calcium density which appear to be due to choroid calcification in the mid-portion of the body of the right lateral ventricle and near the interventricular foramina.

CASE III (N. I. No. 33113). A. W., male, aged fifty-three. The patient was admitted April 25, 1937, because of severe headaches and mental confusion of three hours' duration. He had been in good health aside from mild headaches which had occurred for many years. On the day of admission he had a sudden onset of severe headache followed by a severe backache and mental confusion. There was no loss of consciousness or convulsion. On admission the blood pressure was 146 systolic and 100 diastolic. The heart was not enlarged. There was a slight lower right facial weakness. Deep tendon reflexes were generally slightly hyperactive. Speech was slow and rather indistinct. Ophthalmological examination was negative. The cerebrospinal fluid contained 2.08 million red blood cells per cu. mm. and there was 433 mg. of total protein per 100 cc.

Roentgen examination of the skull was negative except for a punctate shadow of calcium density in the posterior fossa near the midline in the region of the fourth ventricle. A diagnosis of subarachnoid hemorrhage of unknown origin was made. The patient became clear mentally and the facial weakness, increased reflex activity and speech defect disappeared during the five weeks' hospital stay.

On March 31, 1943, six years after the first examination, the patient was in good health

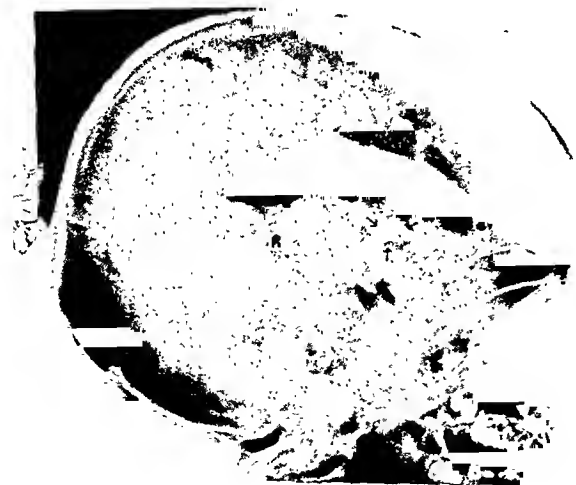


FIG. 9. Case I. Encephalogram showing the posterior calcium shadows to be in the choroid glomera. The anterior calcification appears to be in the plexus tissue near the interventricular foramina.

with no complaints except for occasional headaches which were promptly relieved by aspirin. Roentgenograms of the skull showed no change in the punctate shadow in the region of the fourth ventricle previously described.

*Discussion.* Choroid calcification is ap-

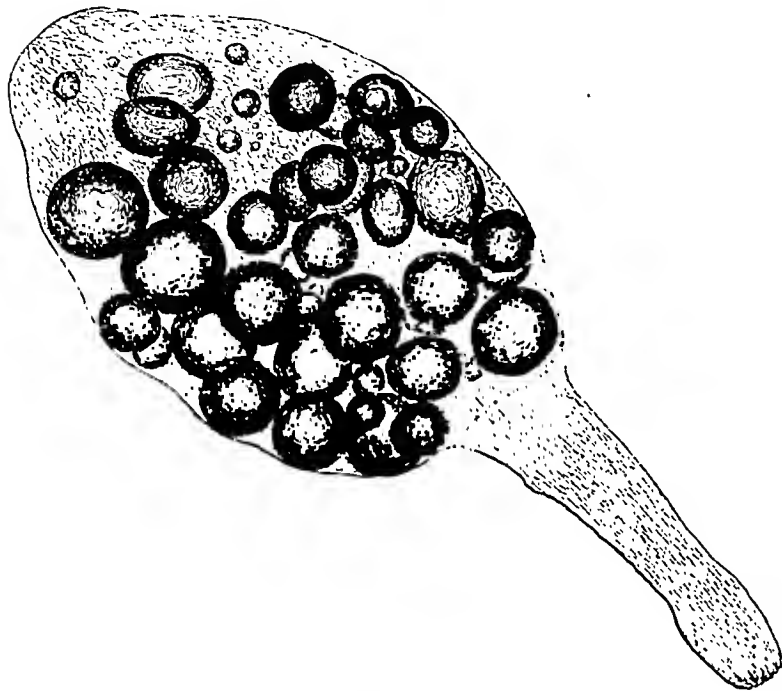


FIG. 11. Psammoma bodies in a choroid tuft of the fourth ventricle (after Virchow).

parently very rarely demonstrated by roentgen methods in the fourth ventricle in contrast to the frequency with which it is found histologically. Virchow<sup>58</sup> long ago

pointed out that the psammoma formations are "an everyday occurrence in the region of the medulla oblongata where they appear in the nipple of choroid plexus on the roof of the fourth ventricle" (Fig. 11). Case III (Fig. 12 and 13) showed roentgen evidence of a punctate calcium mass in the posterior fossa in this region. Laminagrams showing this shadow to be located in the mid-sagittal plane aided in differentiating it from pathological calcification in the cerebellum. The shadow has remained unchanged over a six year period of observation.

#### DISPLACEMENT OF CHOROID PLEXUS SHADOWS BY EXPANDING INTRACRANIAL LESIONS.

The use of physiologically calcified intracranial structures, especially the calcified pineal gland, as landmarks in the diagnosis of brain tumors has been described by Naffziger,<sup>41</sup> Vastine and Kinney,<sup>56</sup> Dyke,<sup>15</sup> Lilja,<sup>36</sup> and others. Newell<sup>42</sup> mentioned displacement of a calcified choroid glomus as an aid in the diagnosis of brain tumor but failed to report the case in the literature. Eight years later Lowman and von Storch<sup>37</sup> formally reported for the first time such pathological displacement. Fray,<sup>25</sup> Childe,<sup>9</sup> Pancoast, Pendergrass



FIG. 12. Case III. A punctate shadow of calcification in the posterior fossa of a man, aged fifty-three, in the region of the fourth ventricle. It has remained unchanged for six years. The pineal is also calcified.

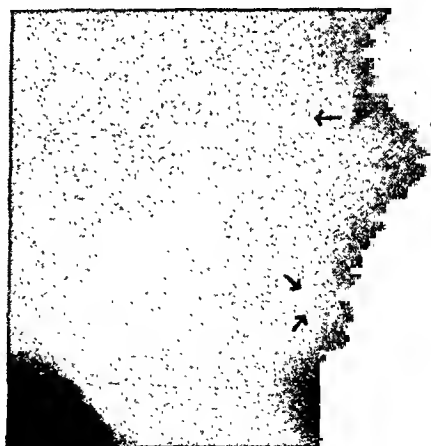


FIG. 13. Case III. A mid-sagittal laminagram showing the punctate calcium shadow to be near the midline.

and Schaeffer,<sup>44</sup> Dyke,<sup>17</sup> and Jacobsson<sup>32</sup> have subsequently described displacement of a glomus by expanding intracranial lesions. Most of the lesions which have been reported as causing displacement of the calcified choroid glomus have been tumors posterior to the glomus or in the temporal lobe, causing forward, upward or medial displacement, or any combination of these three, as emphasized by Fray<sup>25</sup> and Childe.<sup>9</sup>

Displacement of one calcified choroid glomus is occasionally the only evidence on the plain skull roentgenograms of an expanding intracranial lesion. This occurred in the following 2 instances.

**CASE IV (N. I. No. 13276).** J. R., male, aged fifty-five, an American printer, was admitted July 27, 1943, because of headaches and failing vision which he had had for one month. He was asymptomatic until one month before admission when he developed severe headaches, failing memory and vision, and dizziness. He was unable to think of words or to express his thoughts. He showed mental confusion, ataxia and a tendency to fall backward to the right. There was a slight increase in deep tendon reflexes on the right and a right homonymous hemianopsia. Papilledema was present, more marked on the left.

Roentgen examination of the skull was negative except for the abnormal anterior position of the calcification in the left choroid glomus. The pineal was calcified and was in its normal position. Attempted ventriculograms revealed



FIG. 14. Case IV. Anterior displacement of the calcified left choroid glomus by a tumor.



FIG. 15. Case IV. Attempted ventriculogram showing a large gas-filled cyst in the left posterior parietal and occipital regions.

a globular gas-filled cyst in the left occipital region which was interpreted as a cystic tumor. There was no filling of the ventricular system.

At operation a solid and cystic tumor was found in the left occipital region. Histopathological examination of the surgical specimen revealed it to be a metastatic carcinoma of unknown origin.

**CASE V (N. I. No. 16244)** G. D., male, aged fifty-seven, an English mechanic, was admitted June 3, 1933, complaining of loss of memory and difficulty in walking of two years' duration. During this same time he had suffered a personality change. Equilibratory tests were poor. An increase in deep tendon reflexes and a Babinski sign were present on the right side. The patient was mentally deteriorated. The cerebrospinal fluid contained 283 and 4864 red blood cells per cu. mm. on two examinations and the total protein was 100 mg. per 100 cc.

Skull roentgenograms showed the calcification in the left choroid glomus to be higher and more posterior than usual. The sella turcica and posterior clinoid processes appeared normal and the calcified pineal gland was in its normal position.

On the thirteenth hospital day the patient developed fever and physical signs suggestive of consolidation in the left lung. He became progressively worse and died on the seventeenth hospital day. At necropsy (Presbyterian Hospital Autopsy No. 11272) a walnut-sized aneurysm of the basilar artery was found located 1 cm. anterior to its formation from the vertebral



FIG. 16. Case v. Unusual upward and backward displacement of the calcified left choroid glomus by an aneurysm of the basilar artery.

arteries. Two-thirds of its bulk lay to the left of the midline. The wall of the aneurysm was grossly intact. A bilateral lobular pneumonia was present.

*Discussion.* The more common type of anterior displacement of one calcified choroid glomus by a cerebral tumor is illustrated by Case IV (Fig. 14 and 15). An unusual occurrence of upward and backward displacement by an aneurysm of the basilar artery was present in Case v (Fig. 16 and 17). The displaced calcified glomus is of interest as a diagnostic aid in Case v since the basilar artery lesions do not usually show the roentgen changes described by Sosman and Vogt<sup>51</sup> and Dyke<sup>16</sup> as common features of internal carotid artery aneurysms.

#### COMMENT

Disturbance of the usual triangular relationship of the calcified choroid plexuses and calcified pineal gland has been considered evidence of displacement by an expanding intracranial lesion. Varying degrees of asymmetry may be observed in the absence of organic disease or in the presence of hypoplasia or atrophy of one cerebral hemisphere. The view of Jacobsson<sup>32</sup> that asymmetrical calcification in the choroid plexuses does not in itself permit the conclusion that an expanding intracranial lesion is present seems well founded, unless such asymmetry is gross. In the majority



FIG. 17. Case v.

of cases observed at the Neurological Institute in New York in which the plain skull roentgenograms have revealed a definite displacement of one calcified choroid glomus other evidence of an expanding intracranial lesion has also been present.

#### SUMMARY

1. Calcification occurs in the choroid plexuses probably for the most part through a process of proliferation of cells of the pia-arachnoid followed by the formation of a dense collagenous and fibrous reticular meshwork in which calcium salts become deposited.
2. Calcification occurring in the glomera of the choroid plexuses in the lateral ventricles assumes various forms and is frequently asymmetrical.
3. Two cases are described in which roentgenographically demonstrable choroid plexus calcification occurred in unusual positions and at very early ages (two and one-half and three years).
4. One case exhibiting punctate calcification in the region of the fourth ventricle is reported.



5. Two cases are reported in which a displaced calcified choroid glomus was the only evidence on the plain skull roentgenograms of an expanding intracranial lesion.

6. An unusual case of upward and backward displacement of the glomus of a choroid plexus by an aneurysm of the basilar artery is described.

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# PARASTERNAL DIAPHRAGMATIC HERNIA\*

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**D**IAPHRAGMATIC hernia was considered a surgical curiosity which could be diagnosed only at operation or the autopsy table until but a comparatively few years ago. During the past decade, however, this condition has been recognized with ever increasing frequency until it is now generally accepted by clinicians as a relatively common cause of upper abdominal and chest complaints. Due to rapid improvements in roentgen techniques and diagnostic methods, the varied manifestations and great clinical importance of these hernias are becoming more widely understood and appreciated. The tremendous increase in the numbers of cases of diaphragmatic hernia of various types appearing both in the roentgenologic literature and other medical journals is not due to an actual increase in incidence, but rather to the fact that both clinicians and roentgenologists now realize that a hernia may be present in every case presenting atypical, recurrent or persistent upper abdominal and thoracic complaints; and along with this increasing awareness, more thorough search is made for this condition in all obscure cases. Many patients have been saved from exploratory operation or prolonged treatment for neurosis and other incorrectly diagnosed conditions by the roentgen demonstration of a diaphragmatic hernia which adequately explained the bizarre symptomatology.

Diaphragmatic hernia is defined as the protrusion of any abdominal viscus into the thoracic cavity through an opening in the diaphragm. The defect may be the result of imperfect development, anatomic weakness, or trauma, and may be either congenital or acquired. Practically every organ of the abdomen and pelvis except the rectum, bladder and genitalia has been reported as occurring in hernia. Hernias

involving the diaphragm always take place in an upward direction because of the pressure relationship on the two sides of the diaphragm, there being a positive pressure in the abdominal cavity while a negative pressure is normally present in the thorax.

There are numerous types of diaphragmatic hernia and the classification of these lesions is difficult and not yet entirely satisfactory. This is due to the fact that previous writers have used different systems of nomenclature and various methods of classification. However, the following is suggested because of its simplicity and comprehensiveness:

## A. Non-traumatic

1. Congenital (due to embryonic defect)
  - a. Esophageal hiatus
  - b. Pleuroperitoneal foramen of Bochdalek
  - c. Dome of diaphragm
  - d. Foramen of Morgagni
  - e. Absence of a portion of the diaphragm
2. Acquired
  - a. Esophageal hiatus
  - b. Pleuroperitoneal foramen
  - c. Foramen of Morgagni

## B. Traumatic

1. Blows to abdomen
2. Penetrating wounds
3. Perforation of subphrenic abscess or empyema

A brief review of the anatomy will assist in clarifying the pathogenesis of the various types of hernia. The diaphragm is a dome-shaped, musculofibrous septum which serves to divide the thoracic and abdominal cavities. It is composed of three groups of muscular fibers which originate peripherally from the circumference of the thorax and converge to be inserted into a central tendon. The muscular portions are grouped as follows: (1) the sternal part

\* Read at the meeting of the New England Roentgen Ray Society, Boston, Mass., April 23, 1943.



FIG. 1A. Parasternal diaphragmatic hernia. May 21, 1934. Female, aged sixty-four. She has 3 children living and well. Patient entered the hospital complaining of rectal bleeding of five years' duration. Also has gas on stomach, aggravated by eating. Hysterectomy performed thirteen years previously. Barium enema studies reveal a parasternal diaphragmatic hernia and colitis. Roentgenogram of the chest shows a rounded area of mottled density in the right lower lung field. The heart shadow is displaced slightly to the left. The loop of bowel in the thoracic cavity contains gas, producing an area of increased radiance in the paravertebral portion of the right middle and lower lung field.

arising from the posterior surface of the tip of the sternum; (2) the costal portion, originating from the medial surface of the cartilages and the six lower ribs on each side, and (3) the lumbar part, which arises from the lumbocostal arches and crura.

The diaphragm is pierced by three large openings—the aortic, the esophageal, and the vena caval. The aortic hiatus lies slightly to the left of the midline and just anterior to the first lumbar vertebra. The esophageal hiatus is at the level of the tenth dorsal vertebra and is above, in front, and

to the left of the aortic hiatus. The vena caval foramen lies at the level of the fibrocartilage between the eighth and ninth dorsal vertebrae and is anterior and to the right of the esophageal hiatus. Failure of fusion of the costal and lumbar portions of the diaphragm results in a persistent pleuroperitoneal hiatus or foramen of Bochdalek. Lack of fusion of the sternal and costal portions forms the so-called foramen of Morgagni with development of the parasternal diaphragmatic hernia, in which we are particularly interested in the present discussion.

However, even under normal conditions, the so-called Larrey's spaces, which correspond anatomically to the site of the foramen of Morgagni, form congenitally weak areas in the diaphragm which may predispose to herniation. These spaces are

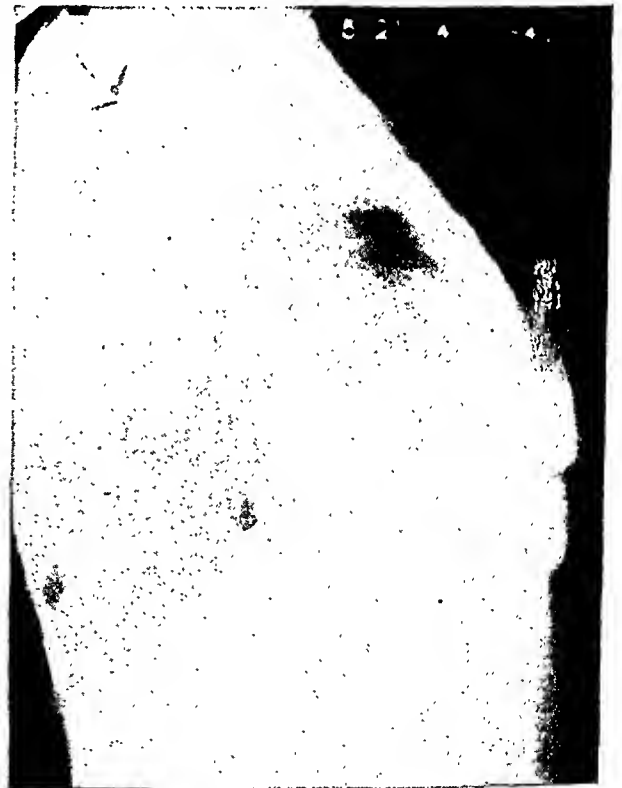


FIG. 1B. Same as Figure 1A, lateral projection. May 21, 1934. The rounded density at the right base lies well anteriorly, the characteristic picture in parasternal diaphragmatic hernia. The gas-containing loop of bowel is seen in the anterior and superior portions of the mass in the right lower lung field.

small, bilaterally symmetrical triangles delimited anteriorly by the sternum, medially by the sternal portion of the diaphragm, and laterally by the costal portion of the diaphragm in the region of its attachment to the seventh costal cartilage. They lie with their apices directed toward the central tendon of the diaphragm and their bases at the costal margins adjacent to the xiphoid. Deficiencies in the diaphragmatic musculature are normally present in these triangles, the spaces being occupied by areolar and connective tissue with a covering of pleura and pericardium superiorly and peritoneum inferiorly. In some instances, the sternal attachment of the diaphragm is entirely absent and the two triangles of Larrey fuse into a single large defect behind the sternum and costochondral junctions with the formation of a large opening through which herniation may readily occur.

Morgagni first recorded a case of hernia

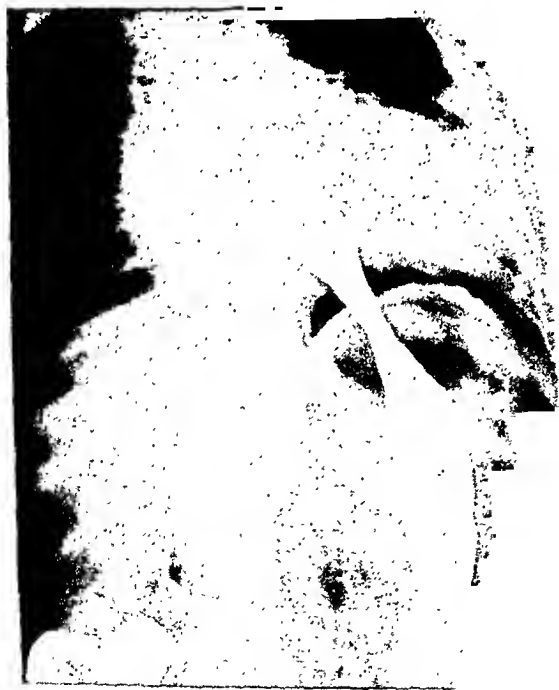


FIG. 1C. Same as Figures 1A and 1B. January 24, 1941. Barium enema studies, posteroanterior projection. The herniated loop of bowel is filled partially with barium mixture and partially with air. There is upward and medialward displacement of the cecum and ascending colon.



FIG. 1D. Same as Figures 1A, 1B, and 1C. January 24, 1941. Opaque enema, lateral projection. The barium filled colon loop above the diaphragm lies well anteriorly, the greater portion of the mass being made up of soft tissues (omentum, etc.). This patient was under observation for almost seven years with no demonstrable change in the hernia.

through the right side of the diaphragm anteriorly in 1769. The number of reported cases remains extremely small, however. During the years 1930-1941, Harrington<sup>1</sup> states that only 24 cases of parasternal diaphragmatic hernia were reported. Morton<sup>2</sup> in 1939 found a total of 120 cases of parasternal hernia recorded in the literature. Their rarity makes them of particular interest and also stresses the importance of a clear and thorough understanding of their manifestations lest they be diagnosed incorrectly or overlooked entirely. It is our impression that cases of parasternal diaphragmatic hernia have frequently been misinterpreted as thoracic neoplasms and that there are actually many more cases in existence than the number of recorded cases leads one to believe. Of particular significance in this respect is the fact that



FIG. 2A. Parasternal diaphragmatic hernia. January 11, 1941. Female, white, married, aged sixty-five. Patient stated she had 21 pregnancies and has 12 living children. For several years, she has suffered with gas, indigestion, and pain in the abdomen and lower back. Six weeks prior to admission, she developed marked anorexia and nausea with dyspnea on exertion. Opaque enema studies show a portion of the transverse colon lying in the thoracic cavity, the pathognomonic finding in parasternal diaphragmatic hernia.

in many instances the condition presents a characteristic roentgen appearance and the diagnosis can be established by roentgenography and roentgenoscopy of the thorax.

We shall attempt in this brief discussion to stress the salient features of the roentgen findings which should direct the observer's attention to the possibility of the presence of this condition and enable him to establish a positive diagnosis of a parasternal herniation. We have made the diagnosis in 6 instances, the majority of the cases having been first demonstrated by roentgenography of the chest and definitely confirmed by studies of the gastrointestinal tract. Since the protrusion of the abdominal

organs into the right chest cavity is apt to interfere with expansion of the inferior portions of the lungs and disturb respiratory activity, the clinician focuses his attention on the chest. Likewise, as the hernia produces a shadow at the base of the lung, the roentgenologist is prone to consider that he is dealing with a pulmonary neoplasm and fails to diagnose the real cause of the condition unless he is alert to the possibility of a parasternal hernia.

It is not universally agreed whether these hernias are congenital or acquired. However, they are doubtless on a fundamental biologic basis and are herniations either through a congenital defect in the diaphragm or the result of faulty attachment of the diaphragm anteriorly. There is usually a peritoneal covering, as proved both by autopsy and at operation, indicating that the peritoneum had been completely formed and had closed off the abdominal cavity from the pleural space before the hernia had developed. It is not possible to explain the occurrence of this



FIG. 2B. Same as Figure 2A. Opaque enema, lateral projection, illustrating that the herniated loop of colon does not comprise the entire chest mass.

lesion on the basis of faulty fusion or malformation of the various components of the diaphragm. The round and falciform ligaments of the liver are usually found in the peritoneum forming the sac, indicating that there is a relationship between the occurrence of the abnormal opening in the diaphragm and the rotation of the liver into the right side of the abdomen during embryonic development. These hernias occur more frequently on the right side because of the more extensive attachment of the pericardium to the left anterior chest than to the right.

As previously mentioned, the incidence of parasternal hernias is very low and they are among the least frequently diagnosed diaphragmatic hernias. The Mayo Clinic<sup>1</sup> figures on the relative incidence were as follows:

Hiatus type	Cases
Traumatic	217
Congenital defect	40
Foramen of Bochdalek	5
Foramen of Morgagni	4



FIG. 2D. Same as Figures 2A, 2B, and 2C. Roentgenogram of the stomach, duodenum, and proximal loops of small intestine, revealing that these portions of the intestinal tract are not involved in the hernia.

In the 4 cases of hernia through the foramen of Morgagni in this series, the lesion extended into the right side of the chest, although in 3 it also extended beneath the sternum. These patients presented complete hernial sacs and the round and falciform ligaments were involved in the peritoneal sacs.

Jenkinson and Roberts<sup>3</sup> in a series of 100 cases found the following distribution:

	Cases
1. Congenital	
Hiatus	78
Right side	2
Left side	5
2. Traumatic	1
3. Eventration	4
4. Short esophagus	5
5. Absence of diaphragm	4
6. Thoracic stomach	1

These lesions have been found at all periods of life from a few days after birth to well into old age. There is no particular sex incidence. The contents of the hernia



FIG. 2C. Same as Figures 2A and 2B. Lateral view of the chest, demonstrating the mass in the antero-inferior portion of the chest.



usually comprise omentum and transverse colon; less frequently the ascending colon, cecum, appendix, and terminal ileum are also in the hernia.

The symptomatology varies very widely. In many there are no complaints referable to the lesion and the hernia is found during routine roentgen studies or at autopsy. In others, there may be symptoms of varying degrees of severity which may simulate ulcer or gallbladder disease, or be bizarre and atypical. Severe constipation is often noted. Strangulation and obstruction, intermittent or recurrent, are relatively common and are reported in 10 to 15 per cent of the patients. Chest complaints include cough, dyspnea, and precordial pain. Frequently the symptoms are referred entirely to the chest, and there is mechanical interference with breathing and lung expansion. The discovery of the large mass in the chest is thus very apt to result in an erroneous diagnosis of neoplasm of the lung.

On physical examination, there is usually dullness over the anteromedial portion of the right lower chest, occasionally extending into the right axilla. Tympany may be present instead of dullness, however, if the herniated bowel loops are distended with gas. A succussion sound synchronous with the heart beat may occur. Borborygmi may rarely be heard. The heart may be displaced to the left.

On roentgen study of the chest, there is density over the lower portion of the right lung field in the region adjacent to the heart border and extending laterally a variable distance, in some instances entirely across the chest to the axillary border. This density may be uniform if the hernia contains only omentum or gut which is filled with fluid. In this case, there is obscuration of the outlines of the right diaphragm, lower ribs, and heart border. The density is usually rounded and presents sharply defined borders. If the colon loops contain gas, there is increased radiability over portions of the mass and colonic haustration may be demonstrable, which is pathognomonic of this condition

and permits of a definite diagnosis of parasternal diaphragmatic hernia. In the lateral projection, the mass occupies the anterior and mid-portions of the right lower lung field and presents rounded, smooth superior and posterior margins; the anterior border merges with the shadow of the anterior chest wall. In every case with this type of shadow, the possibility of parasternal hernia must be definitely considered in the differential diagnosis and should be made as a tentative diagnosis until proved otherwise. The mass does not pulsate and cannot be separated from the right border of the heart shadow. Fluid levels present within the colonic loops may closely simulate encapsulated pleural fluid or abscess. Atelectasis of the right middle lobe was present in the case reported by Colmers.<sup>4</sup>

Barium meal and opaque enema studies are of the utmost importance in the demonstration of this lesion and should be used in all suspected cases. If the omentum only is present in the hernia, there may be only varying degrees of upward and medialward displacement of the right colon, hepatic flexure, and transverse colon. In cases with actual herniation of the colon, there is a large loop of transverse colon lying above the diaphragm with displacement of the adjacent portions of the colon toward the midline and the upper abdomen. The site of the hernia is usually at or slightly to one side of the midline. There may be separation of the afferent and efferent loops. Narrowing of the colon at the point of passage through the opening in the diaphragm is frequently seen. The stomach and jejunum are not involved in the hernia and are in normal position. Roentgenograms in the lateral projection show that the herniated loops lie well anteriorly in the chest just behind the sternum and costochondral region and are narrowed, particularly at the points of passage through the diaphragm, as noted above.

Treatment is conservative and expectant in most instances. The condition may exist for many years with no complaints refer-

able to the hernia and no apparent progression of the lesion. If incarceration or strangulation takes place, surgery is indicated unless relief is promptly obtained by enemata and other conservative measures. Surgery has been resorted to successfully in numerous instances.

#### CONCLUSIONS

Parasternal diaphragmatic hernia is a relatively rare lesion but is of unusual interest to the roentgenologist as he is usually the only one capable of demonstrating the condition prior to operation or autopsy.

The hernia can frequently be diagnosed by anteroposterior and lateral roentgenograms of the chest. The presence of gas-filled loops of colon above the diaphragm in the right lower lung field is pathognomonic. The occurrence of a rounded mass in the anterior portion of the right lung field inferiorly and adjacent to the heart

border requires that parasternal hernia be considered the diagnosis until it is proved otherwise.

The transverse colon and omentum are usually found in the hernia, although other portions of the intestines may also be present. There is narrowing of the loops of colon at the points where they pass through the diaphragm.

Barium enema studies are more satisfactory than the opaque meal examination in the demonstration of the lesion.

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# BILATERAL CONGENITAL FUSION OF CARPAL CAPITATE AND HAMATE

## A CASE REPORT

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**B**ILATERAL congenital fusion of the carpal capitate and hamate appears to be a rare anomaly if judged by the number of reported cases. Kanavel's comprehensive review of anomalies of the hand published in 1932 fails to mention a single instance of such a lesion and there is no record of any similar case in recent years.

Primitive digitate vertebrates possess a distal row of five carpal bones which is reduced to four as the mammal level is reached, e.g., the rabbit, the fourth and fifth primary elements (ulnar) fusing to one

carpus which articulates with the base of both fourth and fifth metacarpals. A similar state exists in some reptiles and amphibians.

According to F. W. Jones, the human carpal bones are in an extremely primitive condition from a phylogenetic standpoint. It is interesting to speculate as to whether fusion of the carpal capitate and hamate represent a phylogenetic advance. Jones quotes Bardeleben and Weidersheim as believing that seven represent the ancestral number of primitive digits and that penta-

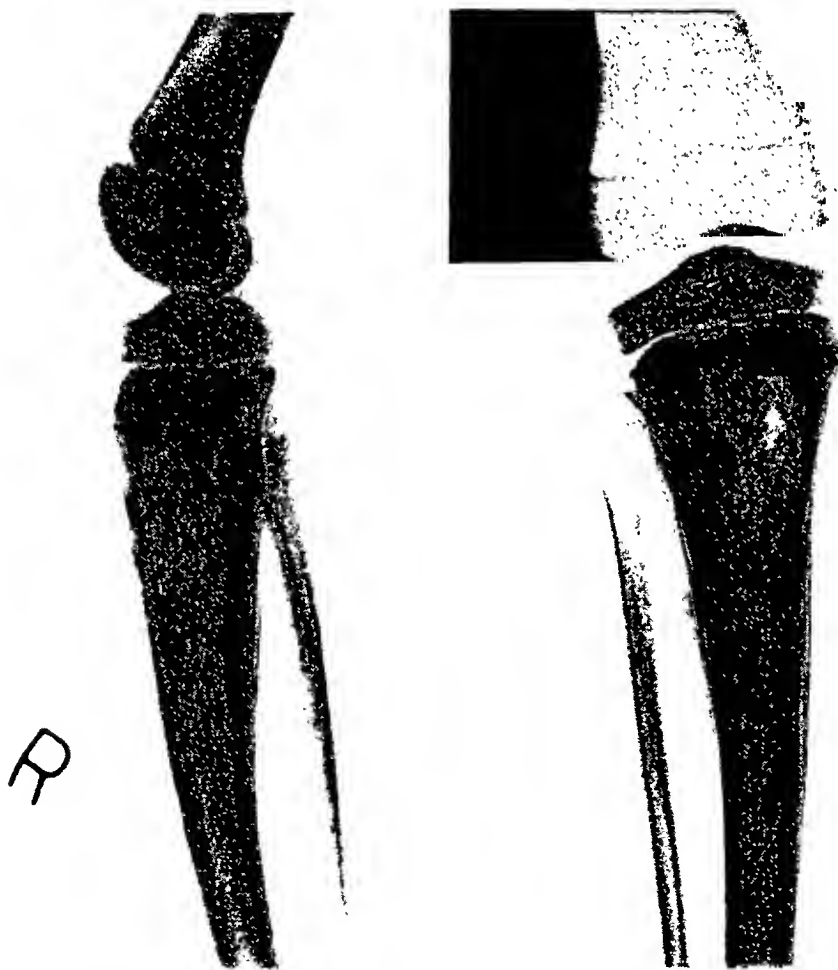


FIG. 1 and 2. Ewing's tumor of the upper right tibia. Metastases were found in the pelvis and chest.

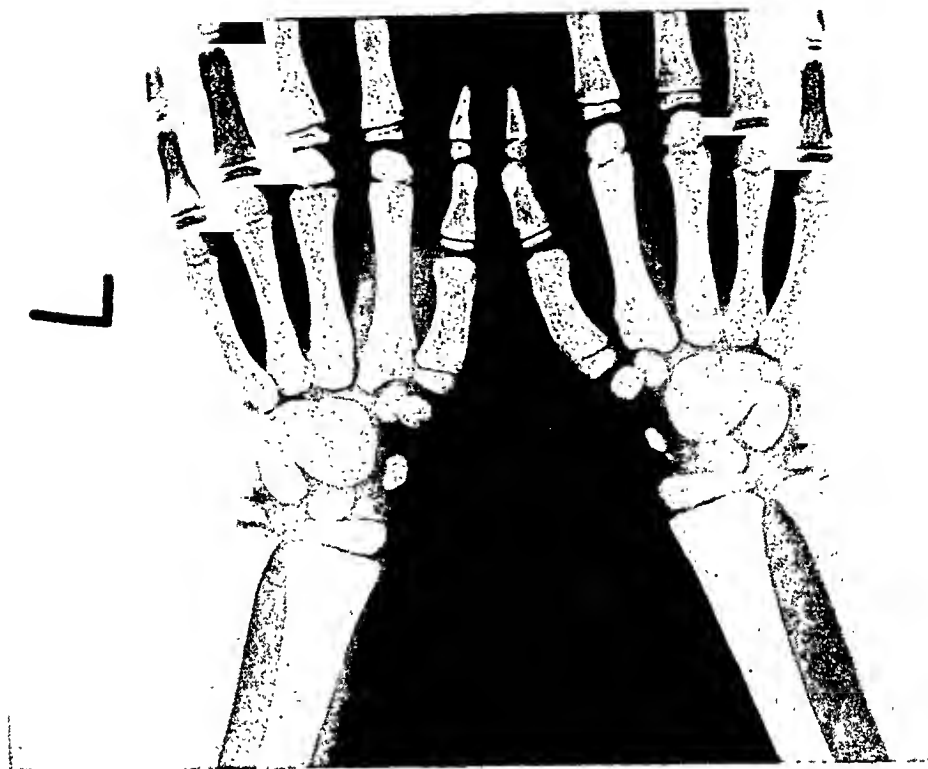


FIG. 3. Centers of ossification for capitate and hamate approximately normal size for age level despite fusion. Ossification of carpus reveals normal maturity except for accessory center in right scaphoid.

dactylism represents a reduction rather than a subdivision of one primary digit. Any reduction in the number of carpal bones under this theory would thereby be considered a phylogenetic refinement.

#### CASE REPORT

L. R., white male, aged nine, entered Children's Hospital, Service of Dr. Paul W. Sutton, on March 21, 1942, because of a painful tumor over the right upper tibia. He first complained of pain just below the knee in September, 1941, at which time he had a low grade fever. He suffered with recurrent attacks of pain and fever until January, 1942, when swelling over the leg was observed. The pain and swelling had increased to such an extent as to prevent walking during the exacerbation. There was no weight loss and the remainder of the history was non-contributory, except that the child was obviously feeble minded. Kahn and Wassermann tests were negative. Roentgenograms (Fig. 1 and 2) suggested Ewing's tumor or osteomyeli-

tis, more likely the former, so that roentgen examination of the entire skeleton was carried out at which time the anomalies of the carpal bones of both wrists were noted (Fig. 3). Biopsy of the tibia was done on March 27, 1942. The sections were examined by Dr. James Ewing who made a diagnosis of endothelioma. After an extensive course of roentgen therapy and in the absence of evidence of metastases, a mid thigh amputation was done on June 13, 1942. Another roentgen examination in October, 1942, revealed multiple chest metastases.

Roentgenograms of the wrists of both mother and father were normal.

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# A VERTEBRAL ANOMALY: PROBABLE PERSISTENT NEUROCENTRAL SYNCHONDROSIS

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RECENTLY I had the opportunity of examining 2 patients who presented an identical spinal anomaly, and because a careful search of the literature failed to reveal any illustration or definite description of this condition, it was regarded as worthy of being recorded. In both instances the findings were incidental and had produced no symptoms.

CASE I. G. V., a white girl, aged twelve, had had epilepsy following a post-measles en-

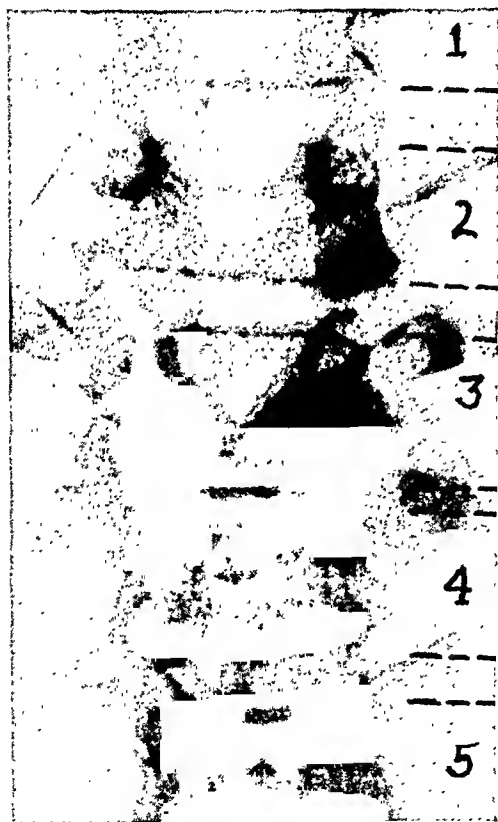


FIG. 1. Case I.

cephalitis at the age of seven. There were no symptoms referable to the spine or spinal nerve distribution. There was no history of injury to the spine.

Figure 1 is an anteroposterior view of the upper dorsal spine. It shows a slight broadening of the third dorsal vertebra with a narrowing of

the intervertebral space between the third and fourth dorsal vertebrae. When, however, the tube is angled 10 degrees toward the feet, as in Figure 2, there is seen a diagonal radiolucent line traversing the upper right margin of the third dorsal vertebra. The projection creates an illusion of seeming fusion of the bodies of the third and fourth dorsal vertebrae. The spinous process of the third dorsal vertebra is hypoplastic, but there is no spina bifida. An anteroposterior view of the cervical spine also showed this defect in the third dorsal vertebra, as might be expected, since the rays reaching this vertebra would be caudad. Figure 3 is a lateral view of the upper dorsal region. It shows the narrowing of the intervertebral disc between the third and fourth dorsal vertebrae.

CASE II. V. S., female, white, aged twenty-one, was in an automobile accident shortly before being examined. She gave no previous his-



FIG. 2. Case I.

tory of injury. She had considerable pain, and the roentgen examination showed an anterior wedging of the third dorsal vertebra, plus a fracture of the superior surfaces of the fourth and fifth dorsal vertebrae and a fracture of the left transverse process of the fifth dorsal. In addition, there were marked hypertrophic spurs between the third and fourth dorsal vertebrae

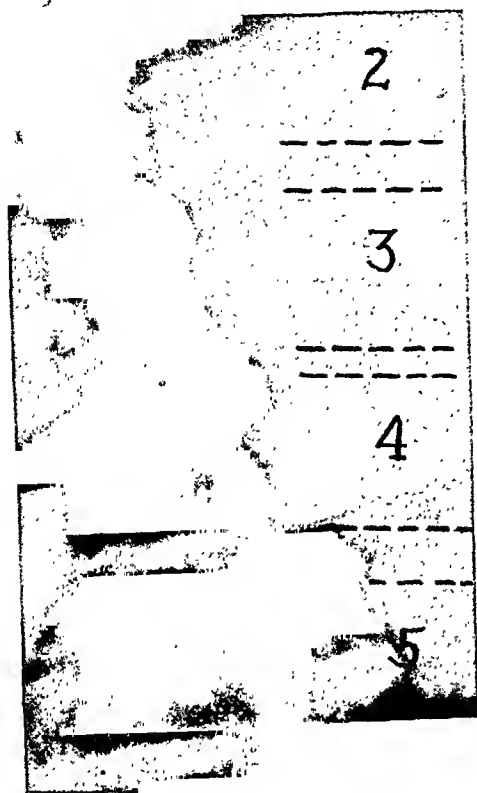


FIG. 3. Case I.

and a sharply localized kyphos in this region, shown in Figure 4.

In this case, an anteroposterior view of the upper dorsal region (Fig. 5), shows the same type of radiolucent line separating the left upper lateral corner of the body of the second dorsal vertebra. It is visualized in the anteroposterior view without angling of the central ray because the vertebra is angulated forward by the kyphos just below it. Note that in each instance the separated corner of the body of the vertebra is slightly elevated, producing a slight tilting of the superior surface of the vertebra and a consequent slight localized scoliosis. In this case, also, there is a false appearance of fusion of the involved vertebra and the one next below, owing to the non-perpendicular angle of incidence of the rays plus the actually narrowed



FIG. 4. Case II.



FIG. 5. Case II.

intervertebral disc space that is present here. In oblique views of the upper dorsal spine, the defect in question could not be visualized. A planigraphic study shows that the defect, slightly curved with convexity downward and inward, lies posteriorly in the body.

In the cases that have been presented, the defect is located on the left side in one case and on the right side in the other, and the appearance of one is almost a mirror image of the other. In both cases the involved upper lateral angle of the vertebral body has become somewhat overdeveloped and more prominent than normal, causing a slight tilting of the superior surface of the body of the vertebra. In both instances, the affected vertebra was associated with some abnormality of the intervertebral disc just beneath it, consisting chiefly of narrowing, and in both cases the spinous process of the involved vertebra was hypoplastic. In both, the upper dorsal region of the spine was involved. And, in both cases, in order for the defect to be visualized, the incident beam had to traverse the vertebral body in a somewhat caudal direction with respect to its sagittal axis.

The interpretation of the appearance described in these 2 cases lies between an acquired defect such as a fracture and a developmental anomaly. The chief evidence for this being a fracture is that the defect does not correspond exactly with any recognized developmental structure. The evidence against this being a fracture is as follows: (1) Whenever a rigid arch is broken, two sites of fracture must ordinarily occur. (2) The appearance is not that of a fracture. The margins of the defect show a narrow uniform zone of increased density, a bony cortex, such as occurs in a persistent ununited epiphysis. (3) Both cases showed no change after a considerable interval of time (fourteen months in Case I and five months in Case II). If this were a fracture, then with the rigid fixation that the mechanics of the arch would provide, one would certainly expect union to occur. Even if one postulates non-union in such a fracture, changes such as increased peri-

focal sclerosis, external callus, hypertrophic exostoses, etc., should occur, and absolutely no change occurred in the time intervals noted. (4) There is no history of trauma in either case (in Case II the known injury could not have produced a fracture that looked old immediately following that trauma). (5) The involved angle of the vertebral body is overdeveloped. There should have been no change if the defect were a fracture. (6) The symmetrical placement and appearance in the 2 cases favors a developmental defect rather than a fracture. (7) While the associated narrowing of the subjacent intervertebral disc could be traumatic, the associated hypoplastic (or absent) spinous process in each case favors the lesion being developmental.

In order to discuss the defect from the standpoint of a developmental anomaly, a brief consideration of the ossification of the vertebra will be helpful. The vertebra is derived from six primary cartilaginous centers. There are two paracentral centers for the body, one for each half of the neural arch and one for each costal process. Ossification takes place in a corresponding manner, although the two lateral centers of the body fuse early and so quickly that it is generally stated that the body arises from one center of ossification. Transitory cephalad and caudad centers may also be present at the beginning, but these also rapidly fuse ordinarily. Recently Ehrenhaft has presented evidence of an anterior and a posterior center of ossification in the body, which also quickly fuse. It is thus seen that there is a multicentric origin of ossification of the vertebral body, following a certain pattern, but ordinarily these multiple centers rapidly fuse to form a single center. Failure of fusion of certain of these centers or their failure of development results in some well known vertebral anomalies, such as anterior spina bifida and hemivertebra. The ossified lateral halves of the neural arch generally fuse by the end of the first year of life. The neural arch fuses with the body of the vertebra between the ages of three and six years. However, the ossifica-



tion center (or centers) of the body does not give rise to the whole of the body, since the posterior lateral portions of it (about one-sixth) are ossified by extensions of the neural arch ossification centers. The cartilage zone that is interposed between the ossification center of the body and that of the neural arch extension on each side is known as the neurocentral synchondrosis.

This synchondrosis runs vertically through practically the entire height of the vertebral body, even though the pedicle of the vertebra arises from the superior portion of the posterolateral aspect of the body. As a result, roentgenograms taken of the dorsal spine of two and three year old boys, directing the central ray from 10 to 25 degrees caudad did not reveal any defect resembling that described above, and this lack of visualization is what one would expect, since the synchondrosis runs vertically and would not be in the plane of the central rays.

The evidence for this defect being a developmental anomaly has already been presented above in the arguments against its being a fracture. The fact that it runs diagonally caudad through the superior pos-

terolateral aspect of the vertebral body instead of vertically through it is the chief objection against concluding that it represents a persistent ununited neurocentral synchondrosis. In order to consider it as such an anomaly, one must postulate that the disturbance that prevents fusion also causes an oblique placement of the synchondrosis. This is not improbable, and until a specimen of such a vertebra is available for pathological study, an interpretation of the defect being reported here as a persistent ununited neurocentral synchondrosis seems to be a justifiable working hypothesis.

#### SUMMARY

Two cases of a hitherto unreported vertebral anomaly, probably a persistent neurocentral synchondrosis with some associated slight changes, are presented, with a discussion of the condition.

The author wishes to express his thanks to Dr. O. V. Batson, Professor of Anatomy in the Graduate School of Medicine of the University of Pennsylvania, for his helpful suggestions.

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# TRACHEOCELE\*

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**D**IVERTICULA of the trachea are infrequent coincidental findings at necropsy and are rarely diagnosed clinically. The limited number of cases reported in the literature have been described under various descriptive titles such as aereocele, bronchocele, tracheaectasy, tracheal hernia, and tracheaectasis.

The "aerial goitre" was familiar to observers as early as the fifth century. Most of our knowledge of this abnormality of the trachea was known prior to the present century. This is interesting when one recalls that much of the progress in the diagnosis of diseases and anomalies of this portion of the respiratory tract has been made in the past twenty years.

The case which is reported below is an excellent example of the truth of the old adage that "all that wheezes is not asthma." This patient was hospitalized because of choking spells, dyspnea, and wheezing with a clinical diagnosis of asthma.

## CASE REPORT

A white male, aged thirty-two, was admitted to the hospital on July 1, 1943, complaining of choking, coughing and shortness of breath.

For the past eight or nine years this patient had had repeated episodes of coughing, wheezing, and shortness of breath, all of which occurred in the fall and winter months.

In the summer of 1942, he developed an upper respiratory infection associated with blood-streaked sputum. He was actually ill for only a few days. Following this illness, he felt well until December, 1942, when his symptoms of coughing, choking sensation and shortness of breath became more constant.

He never noticed chills, fever, chest pain, or expectoration of any type. On occasions, he would be awakened in the night because of coughing and shortness of breath.

His family history was of no clinical significance. He had an appendectomy in 1938; other

than this there had been no illness requiring medical attention.

Physical findings on admission to the hospital showed the patient to be well developed and fairly well nourished. He was short of breath on moderate exertion. There was no cyanosis. No masses could be palpated in the neck. The thorax appeared to be disproportionately large in the anteroposterior diameter as compared with the transverse diameter, and displayed a diminished visible expansion on inspiration. There were rhonchi heard both on inspiration and expiration diffusely disseminated throughout both lung fields. The heart showed no abnormalities. The blood pressure was 120/80, the pulse was regular. The remainder of the examination was normal.

Laboratory findings were essentially normal. Numerous sputum examinations were negative. The patient was tested by the scratch method with many of the more common allergens, and no significant reactions were noted.

Roentgen examination of the chest revealed a slight increase in radiability of both lung fields and low flattened diaphragms consistent with the diagnosis of moderate emphysema. A bronchogram (Fig. 1) showed a cylindrical bronchiectasis of the medial basilar bronchi of both lower lobes. There was also a saccular type of dilatation of the upper third of the trachea (Fig. 2) beginning approximately 4 cm. distal to the larynx. The air-filled diverticulum measured 5 by 4 by 5 cm. in size and originated from a wide neck at the posterior right lateral portion of the trachea. This saccular dilatation displaced the barium-filled esophagus (Fig. 3) to the left and posteriorly. There was also moderate narrowing of the lumen of the esophagus in this area: this, however, was not sufficient to obstruct the flow of thick barium mixture. The lumen of the entire trachea distal to the diverticulum was 5 to 8 mm. wider than normal. There was definitely some redundancy of the trachea, more obvious just distal to the tracheocele.

Bronchoscopic examination revealed approximately the above findings. The entire sac appeared to be covered with normal tracheal

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epithelium, and there was no evidence of retained secretion in the diverticulum. The opening of the saccular dilatation into the lumen of the trachea was almost as large as the sac itself.

While in the hospital, his course was uneventful, and his symptoms were fairly well controlled with bed rest and sedatives.

#### COMMENT

Chiari<sup>1</sup> carefully studied both grossly and microscopically 5 cases presenting

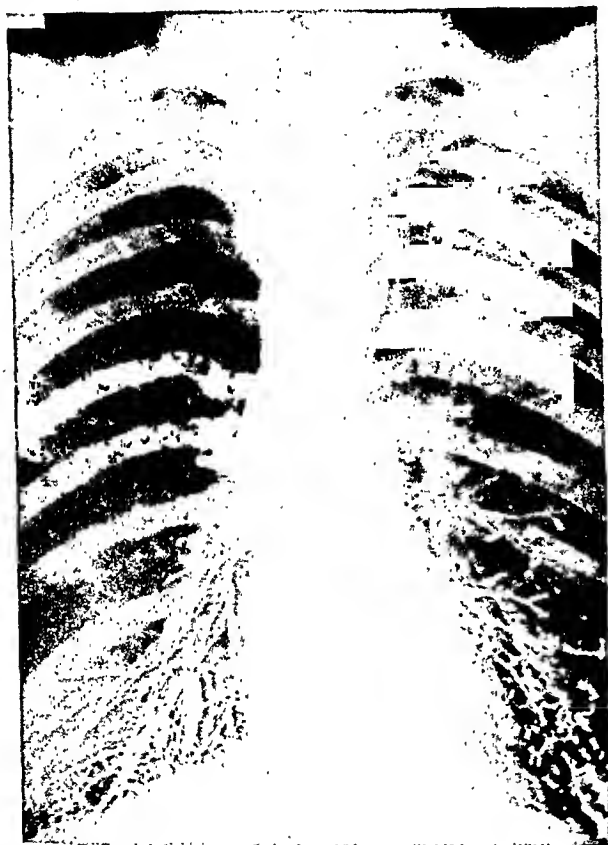


FIG. 1. Posteroanterior bronchogram showing the cylindrical bronchiectasis of the medial basilar bronchi of both lower lobes.

small diverticula of the trachea at necropsy. These all occurred on the right side of the trachea between the seventeenth and twenty-second tracheal rings and the largest measured 6 mm. in width and 12 mm. in length. He was inclined to believe that all of these cases were congenital in origin, and that diverticula of this type were found at the sites where supernumerary bronchi were prone to occur. However, he



FIG. 2. Left anterior oblique view demonstrates the tracheocele (arrow).



FIG. 3. Air-filled tracheocele anterior to the barium-filled esophagus.

was reluctant to exclude the possibility that diverticula of the trachea could occur by the combination of infection in the mucous glands and increased intrabronchial pressure produced by a chronic cough. Choruzenko's<sup>2</sup> case illustrated this possibility.

Miller,<sup>4</sup> in his excellent histologic study of the trachea, describes the posterior wall of the trachea as composed of isolated bundles of trachealis muscle bridging the cornu of the semi-rings of the trachea. Between bands of muscle lie relatively amuscular areas. Development of small diverticula in these amuscular areas seems quite feasible, especially should there be infection of the mucous membrane and chronic cough with resulting episodes of markedly increased intrabronchial pressure. Kahlstrom<sup>3</sup> reported a case where the patient had a chronic cough and physical and roentgenographic evidence of chronic pulmonary infection. At necropsy a series of diverticula were found along the posterior portion of the trachea and larger bronchi in the intercartilaginous amuscular areas, the largest of which measured 7 mm. in depth.

Stibbe<sup>6</sup> states that the congenital type have narrow mouths, and the acquired type a wide mouthed orifice. According to his criteria, the case we have reported would be of the acquired type, and this might seem to be borne out by other evidence of infection of the tracheobronchial tree. However, one cannot forego the thought that were not the infection preceded by an inherent weakness of the posterior tracheal musculature, this tracheocele might never have developed. It is also

interesting to speculate as to whether or not the enlargement of the entire trachea was congenital or acquired and also what part, if any, this played in the production of the large diverticulum.

Olmer, *et al.*<sup>5</sup> described a diffuse dilatation of the trachea in a case that is very similar to ours. Their patient, however, had no tracheal diverticulum or bronchial lesion.

With the more common use of the bronchoscope and bronchography, other lesions of this type will be found and studied.

#### SUMMARY

A case of tracheocele is presented and its probable pathogenesis is discussed. This case was considered to be primarily a congenital defect in the posterior tracheal musculature, with production of a diverticulum by increased bronchial pressure produced by coughing.

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## RADIOTHERAPY IN DUPLAY'S DISEASE

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THE roentgen examination of the shoulder reveals, not uncommonly, the presence of calcium salts in the periarticular soft tissues, frequently between the acromium and the head of the humerus.

These shadows were first described by Painter in 1907. Other investigators (Bergman, Stieda, and others) described them as simple calcareous deposits in the soft tissues.

According to various authors the calcification results from "bursitis" (Codman, Buchner, and others), whence the name of "bursitis deltoidea" or "bursitis calcarea."

Others regard the disease as being a calcified periostitis (Painter, Haenisch, Dickson, Crosby).

Mayer, as well as many others, has identified this morbid condition with that described by Duplay in 1870 under the name of "scapulohumeral periarthritis."

Similar shadows were observed in different articulations other than those of the shoulder by Schmidt, Stegemann, and others.

In 1929, Sandström described his observation at the Hospital Maria in Stockholm, to show that the calcareous shadows are found in other articulations, but less frequently than in the shoulder.

In all the articular localizations there are perfectly analogous local symptoms. According to his opinion the condition is a clinical entity for which he proposed the designation of "peritendinitis calcarea."

Some details about the localization of the calcareous deposits are still controversial. The majority of authors are of the opinion that calcification takes place in tendons and tendinous tissues, and that the bursa is secondarily involved by inflammatory reaction, generally remaining free from calcareous accumulation.

According to Carnett's opinion, the lesion begins with a tendinitis which ends in local necrosis and posterior calcification.

### ETIOLOGY

Regarding the etiology of Duplay's disease, authors differ in their opinions; many causes have been considered but no agreement has yet been reached.

For a long time it was believed that traumatism was an important causative factor, but actual observations do not confirm this point of view, the traumatism being merely regarded, in some cases of the disease, as a simple incidental agent.

It is of interest to draw attention to the similarity existing between this disease and that of Pellegrini-Stieda, i.e., post-traumatic para-articular ossification of the knee joint.

Unaccustomed and exaggerated exercise has also been pointed out as a cause. We have even seen cases in which a simple quick movement has caused the appearance of the typical symptomatology.

Codman asserts that either strain or traumatism may produce little dilacerations in the tendon of the supraspinatus causing clots of blood in the spot where chalky formations will be found later.

Besides the agents mentioned, focal or bursal infections, endocrine disorders, especially those of the parathyroid and even certain metabolic disturbances have been pointed out as causes of predisposing agents of Duplay's disease.

### SYMPTOMATOLOGY

In view of its evolution, Duplay's disease may be divided, in an arbitrary way, into several periods, designated by Codman: (a) acute or spastic; (b) subacute or adherent, (c) chronic; (d) latent.

According to Lattman no exact limit exists between these periods.

If, after an acute attack, a new crisis with the same symptoms on the same side occurs within a short time (from two to four weeks), this relapse may be considered as being the subacute period. According to

Codman's opinion it is during this period that adhesions in the bursa are formed.

The acute form presents the following symptoms:

*Pain.* After trauma, or even without any apparent cause, a very sharp pain radiating down the arm and up to the cervical region suddenly manifests itself. The acute pain is felt in the greater tuberosity of the humerus. The spontaneous pain is sometimes so severe that it causes nausea, and pressure is so intolerable that the contact of clothing becomes unbearable. The radiation of the pain may even extend to the extremity of the fingers. The exact diagnosis for such a sudden pain, when there is no record of trauma, and with this radiation suggesting the distribution of the brachial plexus, is by no means easy, sometimes leading to the diagnosis of a plexitis. The pain often extends to the thorax, in certain conditions causing precordial pain.

We have had the opportunity of observing a patient whose pain suddenly manifested itself during the night, radiating with such intensity down to the arm and to the precordial region that he declared he felt the sensation of approaching death, this complete symptomatology simulating an acute crisis of heart disease. In such cases the diagnosis of cardiac infarction or angina pectoris is not infrequently made.

*Restriction of Mobility.* The pain is followed by an acute spasm of the shoulder muscles with consequent diminution of mobility. This limitation of movement is of various degrees, those of outward rotation and abduction being most acutely affected.

In severe cases, both active and passive movements are limited or even impossible, but in mild cases passive mobility can be maintained to a great extent.

*Calcification.* Calcification is shown roentgenologically. The chalky deposits can attain considerable size. It may be observed that the roentgen examination shows only faint calcareous shadows.

There are clinical cases presenting subjective symptomatology, in all ways similar to that of Duplay's disease, in which the

calcification does not appear in the roentgenogram. Some of these cases are incipient forms of Duplay's disease in which calcification is not yet sufficient for roentgen visualization. However, in cases in which clinical symptoms persist for a long time, without the roentgenological detection of chalky deposits, the diagnosis of Duplay's disease cannot be confirmed.

The size and number of the calcareous deposits are not necessarily proportional to the intensity of the symptoms.

Unilateral pain in patients suffering from bilateral calcification is a frequent occurrence. This fact, as well as the presence of the typical pain in the absence of calcification, makes the relation between the pain and chalky deposits difficult to interpret.

Besides the symptoms which have been mentioned, there are others which may appear during the acute period; for instance, external signs of inflammation such as redness, heat, swelling, pain, and fever. The last symptom is rare but there are cases in which the temperature rises to 40° C.

In the subacute state or even in acute crisis of the chronic period the symptoms are similar to those of the acute form, although less intense but of longer duration.

In the chronic stage, pain is present in a mild degree. The principal symptom is the limitation of movement differing from that of the acute form inasmuch as there is no muscular spasm. The arm can be abducted at most to a right angle with the body. It is in this position that the patient generally feels the greatest pain, but after passing this point he can raise his arm and rotate it backwards without acute pain.

The pain again reaches its maximum when the arm reaches the right angle in the downward movement. This is probably due to the fact that at this angle the bursa is compressed between the greater tuberosity of the humerus and the acromion.

There is a test recommended for observing the intensity of a case: the patient is asked to touch his ear on the side opposite that of the involved shoulder, passing his arm over his head.

There are latent cases with lack of subjective symptoms, in which, during the roentgen examination, chalky deposits, typical of the disease both in form and localization, are accidentally found.

In 20 cases of this kind cited by Lattman the patients were observed during a period of more than five years; 12 of them sooner or later manifested the remaining symptoms of Duplay's disease, some of them attributing the incidental cause to trauma.

#### DIFFERENTIAL DIAGNOSIS

The differential diagnosis must be made from articular diseases such as tuberculosis, lues, cystic bone lesion, giant cell tumor, osteomyelitis and malignant tumors.

Acute cases can easily be confused with acute septic conditions as, for instance, arthritis, osteites and phlegmons.

Furthermore, as already stated, it is not difficult to confuse the symptoms of Duplay's disease with those of neuralgia, brachial plexitis, rheumatism and occasionally with angina pectoris.

The exact diagnosis must be made by a careful anamnesis, local and roentgen examinations.

#### ROENTGENOLOGICAL DIAGNOSIS

In the majority of cases the calcification is easily visualized but it is advisable to make two exposures, one with external and one with internal rotation of the humerus.

As bilateral affection is of frequent occurrence, even when the symptoms are unilateral, it is advisable to roentgenograph both shoulders.

As already stated, the calcareous deposits may be either simple or multiple.

The most frequent localization is near the greater tuberosity of the humerus; sometimes, however, the deposit is found below and in front of the glenoid cavity in the acromion, in the coracoid apophysis or in the vicinity of the lesser tuberosity of the humerus.

Due to the intimate proximity of the anatomical structures of the shoulder it is impossible, in a great number of cases, to

determine the strict anatomical localizations of these deposits.

The most important thing in the differential roentgen diagnosis is the observance of fracture of the greater tuberosity of the humerus, which can easily simulate a subacromial calcified bursitis, especially when the fractured tubercle is drawn by the inserting tendon of the supraspinatus. However, the fracture is always detected on the roentgenogram.

#### TREATMENT

Many forms of treatment have been applied with more or less success.

A simple immobilization of the arm by means of splints and the use of analgesics, even opiates, according to the case, are sometimes tried in the acute phase, and in a great number of cases improvement is observed within six to eight weeks.

Other cases develop into subacute or chronic forms and symptoms can subside or recur frequently.

One case is cited in which a patient who refused any kind of treatment had frequent relapses during a period of twelve years.

Some surgeons and orthopedists, even in cases in which calcareous deposits are found, recommend clinical therapy, reserving surgical intervention only for cases in which a fair trial has been given to all other kinds of treatment, but without results, and when the symptoms, especially pain and limitation of movement, persist.

Physiotherapy has been widely used in various forms including heat, diathermy, sinusoidal and galvanic current, ionization and all forms of massage as well as active and passive movement.

According to Sandström, massage is contraindicated, because he declares it aggravates the symptoms.

At present radiotherapy is being more and more indicated as the most effective therapy in Duplay's disease.

If we consider bursitis as an infection, the beneficial effect of radiotherapy may be explained by the property of roentgen rays to destroy innumerable cells in the



seat of infection, liberating antibodies and lysins which destroy the focal infection.

According to Heidenhain and Fried, its action may be explained by the regressive effects upon the infiltrates in consequence of the liberation of leukocytes.

If we consider the principal symptom in Duplay's disease as a neuralgic manifestation or simple neuritis of the coracoacromial process we can explain the action of the roentgen rays in two ways: (1) According to Freund, Holfelder, Weinberg and various other authors, the beneficial action brought about by radiotherapy is caused by the ability of the rays to relieve congestion and so bring about relief of the compression of the perineural tissues. (2) In Strauss's opinion, variation of the cholesterol-lecithin reserve caused by the treatment is of great importance in the mechanism of nervous action.

Here we must take into consideration the similarity existing between calcified bursitis and post-traumatic osteoma.

Olivier considers the osteoma as a development of periostitic fragments in the muscles, but we can regard it as a simple precipitation of calcium related to a local physicochemical modification, the calcium coming from adjoining bones by way of the humoral or fixing itself directly upon the coagulated blood.

A mechanical factor, be it sudden, prolonged or repeated, is capable of bringing on these benign tumors.

According to Chauvet, Didiée and Pasteur, the earlier the radiation treatment of osteoma is undertaken, the more efficacious it will be and it should consist of intensive local doses repeated daily.

With the suppression of pain, an early result of radiotherapy, normal mobility is restored and the patient can return to his usual activity sooner than from any other treatment.

During the first twenty-four hours after the irradiation, the symptoms are sometimes aggravated, but the following twenty-four hours bring a great relief in the pain and limitation of movement.

In the acute cases, evolution after the treatment is generally as follows: (a) speedy or slow amelioration of subjective symptoms, always with simultaneous improvement of the objective symptoms; (b) the remaining less intense symptoms gradually disappear, with total reabsorption or at least decrease of the chalky deposits. The latter fact deserves special mention.

With repeated roentgenograms Sandström followed, minutely, the disappearance of the process. In some cases the deposits disappeared in two or three weeks but sometimes more slowly. The patient, however, became symptom free even when the chalky deposits were still present, though reduced in density or size.

There are references in the literature to cases in which complete disappearance of the concretions was not noticed, these forms generally presenting bony structure due to secondary osteoblastic formation.

Acute symptoms which usually persist for one or two weeks, in the irradiated patients continue no longer than from three to five days.

Recently Weinberg in his 161 observations declares having frequently obtained extraordinary results which surprised not only the patients but also himself.

In only 5 cases, i.e., in 3.1 per cent, were favorable results not obtained.

#### TECHNIQUE OF TREATMENT

From the standpoint of treatment the existence of a calcareous formation must be considered even though admitting its inflammatory etiology.

We use an average dosage of 150 to 200 r, and six or more applications, with an interval of two or three days between treatments. The low dosage that we use, principally in the first application, is justified on account of the inflammatory process, but the repetition of these doses is necessary in order to obtain the disappearance of the calcification.

With this technique, while avoiding too intense primary reactions, we take care of

all the clinical manifestations of Duplay's disease.

#### REPORT OF CASES

We have treated 30 cases by radiotherapy, but only 18 with sufficient post-therapeutic observation. Of these 18 cases 15 became symptom free, or 85 per cent favorable results. Of these 15 cases, 6 were re-examined roentgenologically, disappearance of the calcification being observed in all of them.

In the other 3 cases, we obtained only symptomatic amelioration. In 1 of these, roentgen examination could not be made after treatment, the second case showed a good temporary result but later recurred, and the third was our only case in which no improvement was observed.

We will present some cases showing interesting findings.



FIG. 2. Case I. Roentgenogram of the shoulder after treatment.

CASE I. C., J. S., male, aged thirty-six.

*Complaint.* Violent fall twenty days before consultation. Severe pain set in four days ago in the left shoulder with scapulohumeral articulation.

Roentgen examination showed "calcification of the subacromial bursa." Even with only unilateral manifestation roentgen examination of the other shoulder demonstrated a bilateral Duplay's disease. This case corresponds, so we believe, to a latent form according to Lattman's classification.

*Result.* Disappearance of all the subjective symptoms. Later re-examination showed disappearance of chalky deposits after radiotherapy.

CASE II. C., F., male, aged fifty-eight. For two and a half months, stitch-like pains in the left shoulder and complete limitation of movements occurred without apparent cause. Special references were made to precordial radiation of the pain leading to the supposition of heart disease. Roentgen examination revealed a calcification of the subdeltoid bursa. Two series of 6 roentgen treatments were given.



FIG. 1. Case I. Roentgenogram of the shoulder before treatment.

*Result.* After the first series of treatments both the pain and mobility have greatly improved, abduction showing less amelioration than other movements. After the second series there was complete disappearance of all symptoms. The roentgenograms no longer showed any signs of Duplay's disease.



FIG. 3. M. R. Roentgenogram upon which the diagnosis of Duplay's disease was based.

CASE III. C., C., male, aged forty-three. For the last week the patient had suffered from severe pain in the right shoulder with complete limitation of movement. Redness and swelling. A three year old roentgenogram showed calcification of the subdeltoid bursa although symptomatology was lacking. A new roentgenogram confirmed the existence of Duplay's disease.

*Result.* A short time after roentgen treatment the patient was able to play tennis again. Roentgenogram reveals no signs whatever of the disease.

CASE IV. S., E. T., male, aged thirty-six.

*Complaint.* For four years diffuse pain in the left shoulder. Six or seven days after a violent movement, a severe crisis in this shoulder occurred with complete limitation of movement. A roentgenogram revealed a calcification of the subdeltoid bursa.

*Result.* Complete disappearance of the symptoms and roentgen signs.

To avoid useless repetition we shall cite no other cases.

I.



FIG. 4. M. R. Roentgenogram taken after treatment in which the bony aspect changes the clinical opinion as to the previous state of the patient.

#### DIAGNOSTIC PROBLEMS

Some fundamental details of the diagnosis seem to call for special mention; first, the frequency of the diagnosis of brachial plexitis in cases in which a roentgen examination reveals a calcification of the subdeltoid bursa; second, the fact that in some clinically diagnosed cases of Duplay's disease the most careful roentgen study is unable to detect the presence of a chalky deposit.

In our experience, in only one of the cases in which we failed to get results, could the roentgenological verification of Duplay's disease never be obtained. The same patient underwent other treatments for several months without results.

Our particular case showing the difficulty of the differential diagnosis, even with all positive clinical tests, deserves to be mentioned.

M. R., female, aged thirty-nine. More than twenty years ago, she suffered for the first time from a pain in the right scapulohumeral articulation resulting from a strain of the arm. Since then any forced elevation brings on the same painful impression of luxation. Four months ago, intense pains were felt with remissions, until eleven days ago, when the pain became most severe and permanent, preventing any movement of the articulation which was also sensitive to touch, with swelling and redness of the whole region. Edema of the whole arm. Fever. The roentgenogram revealed calcification of the subdeltoid bursa.

*Result.* Immediately after the first treatment the pain diminished in intensity and at the end of the treatment movements were free, although slight pain persisted during movements of rotation and abduction. At present, she feels pain in the right shoulder which has no relation, however, to movements.

A roentgenogram shows complete disappearance of the calcification but inside the trochiter invading the articular surface, there is a process of bone destruction with the formation of an irregularly limited concavity. The roentgen image of the referred process is common to luetic osteomyelitis, or tuberculous gumma.

This case has not yet been completely understood by the orthopedists who are still studying it.

The latest roentgenogram excludes this case from the failure of roentgen therapy.

We have decided to present this case considering the possibility of uncommon complications of diagnosis. As is to be seen, all the circumstances—subjective symptoms, objective symptoms and even roentgen examination—led to the diagnosis of Duplay's disease, which, later on, had to be rejected.

#### CONCLUSIONS

1. The roentgenological confirmation of the existence of chalky deposit is a necessary proof of Duplay's disease.

2. Roentgen treatment must be carried out with moderate doses, because of the inflammatory process, and by repeated applications in order to obtain the disappearance of the calcification.

3. According to our observations the

good results obtained by means of radiotherapy are fully confirmed in well identified cases of Duplay's disease.

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# A RAPID RADIUM IMPLANTATION METHOD FOR RODENT ULCER

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IN A previous communication,<sup>1</sup> radium implantation for rodent ulcer (basal cell carcinoma) in the vicinity of the eye was described, and the general conduct of such cases discussed. Seventy-six patients treated in the years 1930 to 1935 were dealt with; only 2 failures occurred, and the incidence of eye damage was very slight except in the case of lesions involving the upper lid. This latter circumstance was explained on physical grounds. The method was regarded as particularly suitable for the most awkwardly placed of these neoplasms near the eye.

Passage of time has not altered the conclusions arrived at, but a modified method has been evolved which has the advantages of compressing treatment into thirty hours, and of giving better cosmetic results. There has been no damage to the eye, even in the case of the upper lid lesions where the risk is greatest. Further, the great flexibility of the method as regards both area and difficult contours is of peculiar value in this type of case since a flat field is rarely obtained, especially at the common inner canthus site. The efficiency of the method and the lack of conspicuous tissue change render it well worth the short time involved; patients can have the treatment one forenoon and go home the next afternoon, being in the hospital for one night only, unless they wish to stay longer.

The method was put into use in May, 1939, and is therefore of comparatively recent development, but with this type of tumor it would appear reasonable to draw some deductions. At the time of writing the earliest cases are of over four years' duration.

## THE METHOD

Details of the implantation method were

given in the original paper, and it will therefore suffice to state that the operation is carried out after minimal injection of 2 per cent novocain with adrenalin and that painting the skin with proflavine oleate 1 per cent in liquid paraffin<sup>2</sup> deals with any local sepsis. The needles used (Fig. 1) are of small dimensions having a total length of

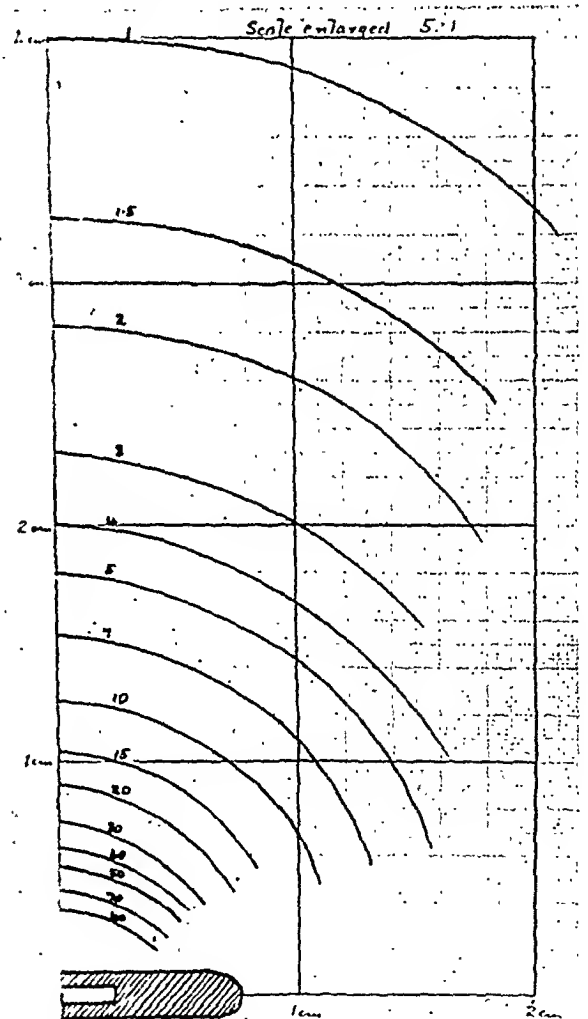


FIG. 1. Isodose curves round 2.0 mg. needle, 15 mm. long, 0.6 mm. Pt wall and active length 4.5 mm. Half the needle is illustrated; the curves are drawn as dictated by convenience and not in arithmetical progression.

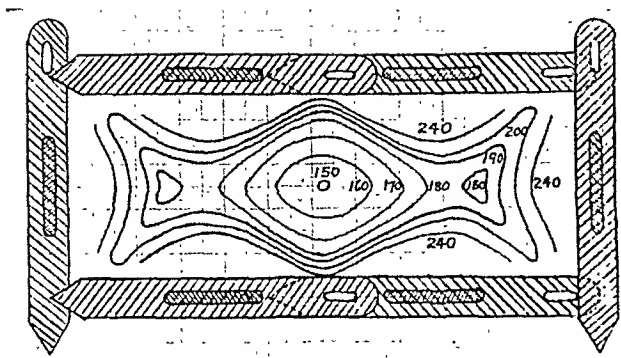


FIG. 2. Isodose curves within the basic 2.5 by 1 cm. plane (roentgens per hour).

15 mm., with an active length of about 5 mm., 0.6 mm. platinum walls, and radium content 2 mg. (element). Each needle is retained in position with a fine silkworm stitch across the puncture. The shortness of the individual needle renders the plane very adaptable to the circumstances of each case.

The basic arrangement is a rectangular plane 2.5 by 1 cm. in size, made of six such needles (Fig. 2); a four needle square is hardly ever large enough. As has been said, this is readily fitted in to varying contours, and expanded as required, in which case the necessary center line will contain less

radium than either side. For "filling in" the larger rectangle the most appropriate size in the Western Infirmary stock is 20 mm. long, 8 mm. active length, with 1 mg. radium (element) and 0.6 mm. platinum filtration. In a number of cases the 2 by 2.5 cm. planes have had a center line made of

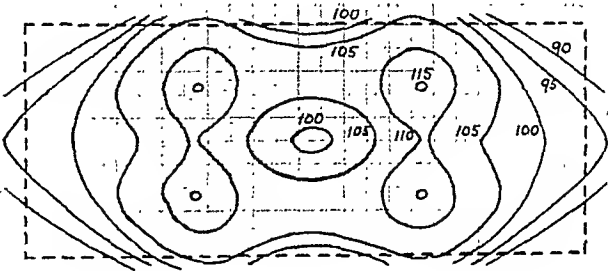


FIG. 3. Isodose curves 0.5 cm. away from 2.5 by 1 cm. plane showing uniformity of dose rate at presumed skin surface (roentgens per hour). Dose taken as 100 r/hr.  $\times$  30 hr. = 3,000 r.

the 2 mg. needles, and the higher dose still seems within the limit of what can be tolerated without tissue damage. The implant is carried out as nearly as possible 0.5 cm. below the skin and the dose distribution "at the skin" is illustrated in Figure 3. Since no operator, however experienced, could

TABLE I  
SOME REPRESENTATIVE DOSAGE RATES IN RADIUM IMPLANTS  
(roentgens per hour)

		In Plane	0.5 cm. from Plane
Standard six needle implant. 6 $\times$ 2.0 mg. radium element, 15 mm. long, 2.5 $\times$ 1.0 cm.	Center	150	99
	0.8 cm. from center on long axis of rectangle	190	104
Ten needle implant. 10 $\times$ 2.0 mg. radium element, 15 mm. long, 2.5 $\times$ 2.0 cm.	Center of one rectangle	174	122
	0.8 cm. from center on long axis of rectangle	216	145
	Center of whole figure; i.e., over central line of radium	—	131
Ten needle implant. 8 $\times$ 2.0 mg. radium element, 15 mm. long, 2 $\times$ 1.0 mg. radium element, 20 mm. long, 2.5 $\times$ 2.0 cm.	Center of one rectangle	148	104
	0.8 cm. from center on long axis of rectangle	186	129
	Center of whole figure	—	105



claim to place the needles exactly at this depth, the skin dose will presumably vary between the rates shown "in plane" and "0.5 cm. away," but the skin effects observed indicate that something near enough to the ideal arrangement is very usually attained (Table 1). This is so even when the thickness of tissue is slight.

During treatment the eye is not bandaged over since this tends to produce conjunctivitis (Fig. 4 and 5) and acriflavine drops 1:1000 are used freely. After removal of the needles, the skin is gently washed and sterile sulfanilamide powder carefully dabbed into the punctures, and over the treated area. This keeps the skin both clean and dry, thereby reducing reaction, and a clean protective scab generally forms so that no dressing is required in many cases.

The patient is advised to avoid undue exposure for a day or two as a precautionary measure. A simple boracic eyewash is prescribed and the treated skin should be kept dry. As will be seen from Figure 3, the skin dose is approximately 3,000 r in thirty hours. The usual reaction consists of erythema and dry desquamation, and only where there has been epiphora is a moist reaction likely, unless there is a good deal of local ulceration to start with. Some transient congestion of the adjacent conjunctiva occurs. The cosmetic results are usually excellent, and the punctures prove incon-



FIG. 5. Method of dressing implant shown in Figure 4 without including the eye.

spicuous as a rule, perhaps because they are open for so short a time.

*Technique for Upper Eyelid.* Former experience has emphasized how dangerous treatment of the upper eyelid may be, since, of the 4 cases previously reported, 3 showed late eye changes and 2 actually suffered from loss of vision; it was shown experimentally that the dose received by the eye from an implant in this situation is much greater than in the case of other sites. With the special technique now evolved, no eye damage at all has been seen in the 5 cases treated, nor in those at the inner or outer canthus with spread to the upper lid.

Adequate protection by filtration would hardly be possible with gamma radiation; it would be impracticable to insert enough metal below the eyelid. It was therefore decided that a trial should be made of distance protection only, since the physical characters of a radiational plane of this type are such that the intensity very rapidly falls off above or below it. Thick contact glasses were employed, and one of these raises the upper lid almost 0.5 cm., thereby reducing the radiation incident on the globe by some 50 per cent. After the implant is completed, the eye is anesthetized with cocaine drops and the glass slipped into position. The whole arrangement is stabilized by stitching the upper lid to the cheek (Fig. 6 and 7). The method appears to cause no great inconvenience to the pa-



FIG. 4. Implant in position for rodent ulcer at outer canthus.



FIG. 6. Implant for rodent ulcer of upper eyelid. Contact glass in position, and the lid is stitched to the cheek.

tient, nor is there trouble with the eye (Fig. 8).

Nothing but some congestion in the conjunctiva is seen and this soon passes off; none of the 5 cases has shown any eye damage. In the case of upper lid implants it is not necessary to close the ends of the rectangle unless the lesion is of some size, so only four needles would be employed. Closure can be carried out when it is called for, but may make the operation a little more difficult. The dosage rate naturally falls considerably at the ends of an open rectangle, and care must be taken that the lesion lies well inside; at the extremities the dose delivered would be about half that at the center.



FIG. 7. Contact glass just removed from the eye shown in Figure 6. The staining of the skin here and in Figure 6 is due to the use of proflavine.

#### CASE DETAILS

Sixty-two patients have been treated by the rapid method between May, 1939 and December, 1942. These include 3 cases of squamous epithelioma affecting skin in the eye region, although the method was not designed for this type of growth. The remainder are basal cell tumors of which 29 were at the eye and the others in various positions about the nose, cheek, or ear (Table II). Biopsy was seldom performed, the nature of most of the cases being obvious clinically.



FIG. 8. Present condition of the patient shown in Figure 6. There are no eye changes.

#### RESULTS

*Squamous Epithelioma.* The 3 squamous epitheliomas are dealt with separately, since it is by no means clear that the dose given is the ideal one for this histopathological type. One extensive lesion occurring near inner canthus in an aged subject did not appear to respond at all, but a second, treated in 1940 for a lesion at outer canthus involving both lids, received in addition a surface dose of 1,000 r in about twenty-four hours and has done well. The preliminary eye examination revealed some lens opacity in both eyes, together with a chronic atypical glaucoma which has required operative treatment, one eye having been trephined. The third case was treated

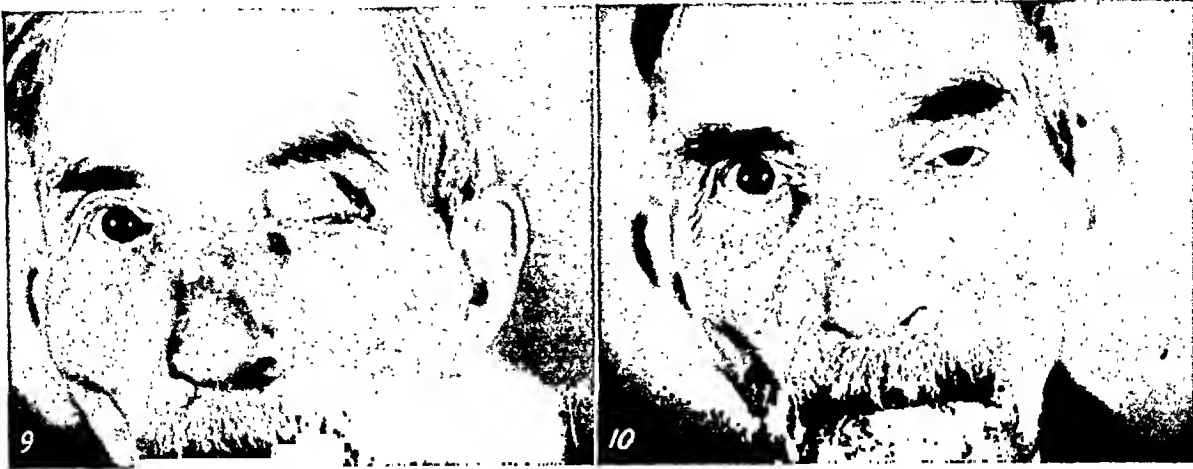


FIG. 9. Squamous epithelioma of the eyelids extending from the cheek where the pale area indicates previous use of CO<sub>2</sub> snow. The lids are completely rigid through infiltration from the tumor (biopsy performed).

FIG. 10. The patient shown in Figure 9 after treatment by rapid implant. The palpebral fissure is narrowed but the lids now open to some extent.

in 1942 and the lesion, which had begun in the malar region, had received treatment with CO<sub>2</sub> snow. This part was healed with dense scarring, but the growth had extended to the lower lid, outer canthus, and upper lid. A rapid implant alone was used to treat these regions, and the parts have healed well; the condition of the eye is excellent though the palpebral fissure is naturally narrow (Fig. 9 and 10).

*Rodent Ulcer.* There were 59 cases of rodent ulcer, situated as indicated in Table II. The lesions are described according to their origins but in a number of cases trans-

gress the primary site, as when an inner canthus growth extends to one or both lids. All present soundly healed areas of skin except 3 where recurrence took place. One of these lesions was on the ala nasi (1941) and no reason is obvious for the failure. The second (1941) was a rodent ulcer in mastoid region involving the ear, and cartilage invasion had occurred so that surgical intervention was likely to be the ultimate outcome; it was successful. The last case presented a very infiltrative lesion of some duration at the inner canthus (1942). It healed well but growth re-appeared late

TABLE II

	Epithelioma of Eye Region	Rodent Ulcer				
		Eye Region				Face Excluding Eye Region
		Upper Lid	Lower Lid	Inner Canthus	Outer Canthus	
1939	1	1	0	1	1 = 3	0
1940	1	0	1	2	2 = 5	6
1941	0	0	2	3	0 = 5	7
1942	1	4	2	7	3 = 16	17
		5	5	13	6 = 29	
Totals	3	29				30 = 62

looking rather as if it had come from below, and it would seem likely that there was deep invasion into the orbit on a scale not obvious clinically. Apart from these 3 failures, mention must be made of 1 upper eyelid case (Fig. 11 and 12). The lesion was extensive and infiltrative, and one tiny nodule of recurrence became obvious a year after treatment. This was promptly excised and

of superficial skin slough some time after treatment, but under exceptional circumstances due to undue exposure at work in a shipyard, and as driver of a railway engine. Two others show a good deal of fibrosis but one had previously been given some treatment with CO<sub>2</sub> snow; and, finally, 2 show a distinct scarred depression corresponding exactly to the size of the original lesion and



FIG. 11. Somewhat extensive rodent ulcer of the upper eyelid (biopsy performed).

FIG. 12. The case shown in Figure 11 after treatment. The eyebrow is somewhat epilated.

the microscopic report indicates that the margins appear adequate.

#### IRRADIATION SEQUELAE

*Skin.* The appearance of the skin after treatment is of particular significance in the case of facial lesions, and it is therefore important that the cosmetic results have been good, representing an improvement on the older technique. Where a malignant ulcer has destroyed much tissue, scarring must inevitably result to some extent, and a number of the cases had been quite extensively involved in this way. As a rule, however, there is little to be seen if some slight local pallor is allowed; when this occurs it is rendered less obvious by having no sharply defined margin. The guiding principle in assessing results would seem to be that the changes, if any, should not be conspicuous to the casual observer, and this has been the case except in 6 cases out of the total. Two cases developed small areas

not to the area irradiated. Purely irradiation changes of undesirable extent in the skin are probably the result of faulty needle insertion with reference to the skin surface; or to there being very little subcutaneous tissue, as at the bridge of the nose, so that the needles are very near the skin. One or 2 cases show some tendency to formation of blackheads at or near the original site, but this usually happens in patients who do not give the skin reasonable attention. Three of the cases—2 at the inner canthus, and 1 at the upper lid—were recurrent after operation, so already had small scars. No trouble with underlying cartilage or bone has been encountered.

*Eye.* As in the past, these patients undergo ophthalmological examination before treatment and at intervals afterwards, so that the significance of any findings can be more readily assessed in relation to what has been done. Quite a number showed some change or other at the first examina-

tion, including lens opacity, vitreous opacity, vascular changes, choroiditis, and so forth; while several were already troubled by epiphora. One eye had already been largely disorganized by sepsis in a case of extensive and neglected rodent ulcer involving both lids, and in another case both eyes showed some lens opacities with cupping of discs, but no rise of intraocular

in appearance and position, it is evidently the duct which is involved, and it is difficult to see how this can be avoided in a certain proportion of cases, since any form of treatment must cause some fibrosis during healing. If the lesion is in the vicinity of the duct, the lumen is therefore likely to be narrowed or even seriously obstructed. The situation may be summed up by saying



FIG. 13. Rodent ulcers of face. The inner canthus rodent is beginning to involve the eyelids.

FIG. 14. The case shown in Figure 13 after treatment. There is slight pallor at the inner canthus where the growth was somewhat infiltrative.

pressure. It is beyond the scope of these notes to discuss such incidental findings, and only changes seen for the first time after treatment need be referred to. It is worth observing, however, that the case notes do not indicate that any of these conditions were made worse by the treatment, with the possible exception of the septic eye which was already lost as a functional unit.

Epilation of eyelashes has not occurred to any great extent, and where it has been observed has not been obvious except on close examination. One case has a moderate degree of ectropion. Those patients with epiphora naturally continued to complain of watering of the eyes, but one now thinks that the treated eye is worse; 3 cases developed this symptom after irradiation. Astringent drops or washes containing zinc sulfate may be helpful, and dilatation of the tear duct is occasionally tried. As epiphora may occur when the punctum seems normal

that the total number recorded as complaining of new or old watering of the eye or eyes is 8—4 had lesions at the inner canthus, 3 at the lower lid, and 1 on the cheek.

The only abnormalities observed to develop within the eye have been senile changes in the lenses and vessels of both eyes in a patient aged seventy-five. No intraocular damage was seen, even in the upper lid cases. In view of the short time during which the later patients have been observed, it should be stated that any serious ocular complication from irradiation, except cataract, would almost certainly be well developed by now; and that, even in the older series of cases, where larger doses were employed, cataract was not encountered to any extent.

#### COMMENT

It is fully realized that the lapse of a few more years would give more weight to what

has been said regarding the efficacy and safety of this rapid implantation method, but the results have been uniform enough to make it appear worth while recording what has already been accomplished. The method is now in regular use for appropriate cases, and these comprise basal cell lesions anywhere, but especially in awkward sites with difficult contours, such as are met with most often around the eye, and occasionally about the nose. It is claimed that the method, in the time observed, has been very efficient, and that post-irradiation trouble has been quite unusual in the skin and was not found in the eye apart from some watering. Further, the saving in time is considerable as compared with older implantation methods. I consider that the cosmetic results are especially good; as has been indicated, the site of treatment is often difficult to distinguish and this alone would seem to make the time of thirty hours worth while spending.

One point of special interest to radiotherapists is the adjustment of the dose to suit the altered treatment time. Reduction in time inevitably implied a lower dose, and the problem was to find one high enough to deal with the tumor, yet not too great for the lower tissue tolerance associated with a short exposure. A skin dose of about 3,000 r in thirty hours appears to answer well; it has been effective without causing excessive reaction or post-irradiation stigmata of note, and no doubt the small volume irradiated has helped in this respect. Basal cell carcinoma is usually so radiosensitive as to lend itself admirably to this type of treatment, and it is a matter of interesting speculation how far the idea can be applied to epitheliomas of the squamous type. The 3 cases cited give at least a suggestion that something can be done along such lines.

For more detailed discussion of the action of radiation in the region of the eye and appropriate references the reader is referred to the original paper.<sup>1</sup>

#### SUMMARY

A method is described whereby basal cell carcinoma can be treated by implantation of radium in the reduced time of thirty hours. It is claimed that this method appears to be both efficacious and safe so far as it has been observed, and that this is particularly true of the more awkwardly situated lesions on the face. Sixty-two cases were treated in the years 1939 to 1942. There were only three failures, two of which might have been expected, and a fourth case required slight extra attention. It is fully realized that the duration of the follow-up is short, but the results appear sufficiently interesting to merit recording.

A new technique has been evolved for dealing with tumors of the upper eyelid in order to eliminate damage to the eye.

No ocular damage has been encountered in any of the cases described.

I have pleasure in acknowledging the assistance of Professor A. J. Ballantyne, and later of Professor Brownlow Riddell, and their assistants, in examining these cases at the Eye Department, Glasgow Western Infirmary; Professor Lowenstein, at present attached to the Department, kindly supplied the contact glasses. The physical calculations were originally made for me by our physicist, Dr. John Thomson, and after his departure for war duties, by Dr. Walter McFarlane, who is also responsible for the isodose curves. The Visiting Staff has been most helpful in providing ward and theater facilities.

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# ~ EDITORIALS ~

## ELECTRONICS AND POST-WAR RADIOLOGY

THE Allied war effort owes no little part of its success to the contributions of the science of electronics. Although most of the developments which have occurred in this field remain cloaked in secrecy for reasons of security, it is evident that electronic devices have played and will continue to play a decisive rôle in the solution of many military and naval problems.

The peace-time applications of electronics promise to be no less spectacular than the military. Indeed many imaginative minds envisage an almost incredible future for the science in industrial, agricultural and domestic pursuits. Instruments with which the hazards of aviation will be enormously reduced, new control devices to facilitate our daily routine and rapid advances in television and communications equipment are but a few of the many developments which even the conservative foresee.

Electronic engineering also will have a far-reaching influence on the science of roentgenology. This relationship is a subtle one for the development of the roentgen tube constitutes one of the first practical applications of electronic research.

In medical roentgenology several electronic developments seem imminent. One is the grid-controlled roentgen tube. This device is similar to present-day models but includes in addition to the anode and cathode an interposed electrode having a grid-like structure. This additional element permits increased efficiency in tube operation and also provides a simple means whereby target size may be regulated.

Another electronic device which may prove useful is the photoelectric timing mechanism. This instrument completely

automatizes the roentgen procedure so that a technician is required merely to place the subject before the roentgen machine and to close the exposure switch. Time-wasting measurements of anatomical thickness and adjustments of equipment are unnecessary. By its inherent design, the mechanism terminates roentgen exposure at the instant when a film has received the quantity of radiation required for correct exposure. Excellent uniformity of roentgenographic quality thereby is assured. The photoelectric timing mechanism consists essentially of a multiplier phototube with an overlying fluorescent screen and a condenser-thyratron-relay system. The phototube occupies a position immediately below the center of the cassette and records the relative intensity of the roentgen radiation reaching the film. The response of the phototube is integrated by the condenser-thyratron-relay system and the exposure terminated by the opening of the relay's contacts when a certain quantity of radiation has been delivered to the film.

At this writing, grid-controlled roentgen tubes and photoelectric timing mechanisms appear quite practical. They constitute, however, relatively minor contributions. Of much greater significance is the possible development of equipment whereby fluorescent images may be amplified. It must be admitted that the perfection of such devices seems unlikely in the immediate future, but their potentialities are so spectacular as to arouse immediate interest.

From the earliest days of roentgenology, fluoroscopy has remained at a stage analogous to that occupied by the crystal-set in radio. The usefulness of the method has been enormously limited by the low visual

acuity which an observer possesses when working at the low levels of illumination which exist under fluoroscopic conditions. Accordingly most roentgen procedures are conducted with roentgenography, even though this process introduces many technical and clinical disadvantages. It has long been recognized that the limitations of fluoroscopy would be effectively overcome if fluorescent images could be amplified several thousand times so that the illumination of the screen approached the brightness of the usual roentgenographic viewbox. Under these conditions visual acuity is high and pathological processes then could be visualized in multiple projections with the same clarity as that provided by roentgenography. Furthermore, dark adaptation of the operator would no longer be required; indeed fluoroscopic examinations could be conducted in normally lighted rooms, thus permitting the use of roentgen methods in surgery. The use of sufficient amplification would also allow a considerable reduction in the intensity of the exposing radiation. Radiation hazards thereby would be largely eliminated. With fluorescent amplification, roentgenographic procedure would be tremendously simplified for if roentgenograms should be desired it would be necessary merely to photograph the fluorescent screen. Thus powerful roentgen equipment would seldom be required.

Several methods whereby fluorescent amplification may be accomplished have been proposed. One suggests the use of television equipment including the usual iconoscope (television camera), vacuum tube amplifier and kinescope (television projector). The sensitivity of present-day iconoscopes is so low, however, that the amplified image is obscured by extraneous random "noise" generated in the amplifier. Television developments which have occurred during the war may markedly alter this situation but it seems unlikely that such methods will solve the problem of fluorescent amplification. Another method proposed by Langmuir suggests the use of an electronic image tube. This device,

schematically illustrated in Figure 1, consists of a cylindrical glass envelope including a fluorescent surface backed by a photoelectric layer at one end of the tube and another fluorescent surface at the other. Along the axis of the tube are cylindrical

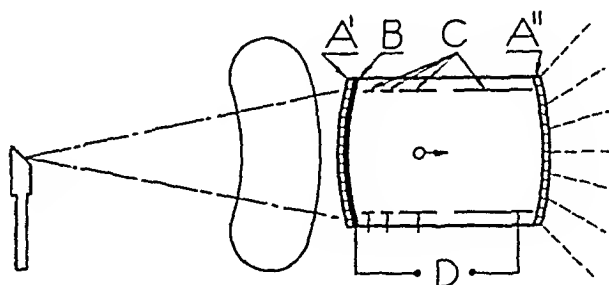


FIG. 1. Simplified schematic diagram of Langmuir image tube.  $A'$ ,  $A''$ , fluorescent surfaces;  $B$ , photoelectric surface;  $C$ , cylindrical electrodes;  $D$ , high voltage, d.c. source.

electrodes which serve to focus the electronic image. When roentgen rays impinge on the first fluorescent surface,  $A'$ , the roentgen image is converted to a light image which in turn is converted to an electronic image by the adjacent photoelectric layer,  $B$ . If a high voltage electrostatic field is applied in the long axis of the tube, the electronic image will be projected on the second fluorescent surface,  $A''$ , there to be reconverted to a light image. The gain in brightness of the second surface over that of the first will depend on the efficiency of the photoelectric layer, the voltage applied to the tube and the types of fluorescent materials employed. It has been estimated that image tubes may be constructed having an amplification between 10 and 100 times. Although this is a step in the right direction, it is hardly sufficient to fulfill the needs of fluoroscopy.

Another device, the electron multipactor tube suggested by Farnsworth, may provide the eventual solution to the problem. This instrument, illustrated in Figure 2, is similar to the Langmuir image tube but also includes a second photoelectric layer,  $B''$ , applied to the fluorescent surface,  $A''$ , at the viewing end of the tube. Furthermore a high frequency rather than a d.c. electro-

static field is employed. As in the simple image tube, a roentgen image is converted to an electronic image at the first fluorescent-photoelectric interface,  $A'$ ,  $B'$ . This electronic image is projected upon the distal

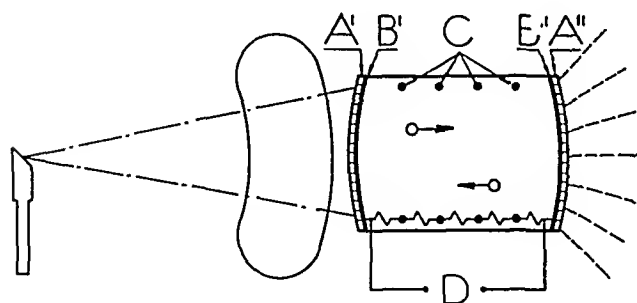


FIG. 2. Simplified schematic diagram of Farnsworth multipactor tube.  $A'$ ,  $A''$ , fluorescent surfaces;  $B'$ ,  $B''$ , photoelectric surfaces;  $C$ , guard-wire electrodes;  $D$ , high frequency, high voltage source.

end of the tube by the electrostatic field where it first encounters the second photoelectric layer,  $B''$ , and then the underlying fluorescent surface,  $A''$ , where it is reconverted to a light image. When an electron impinges on a photoelectric surface it causes the ejection of several other electrons by secondary emission. This effect is analogous to that which occurs when a droplet falls in a pool of water. The interaction of the droplet at the surface of the pool causes several small droplets to be thrown into the air. If the frequency of the

electrostatic field is such that the field reverses just at the instant when the original photoelectrons impinge on the second photoelectric layer,  $B''$ , the electrons produced by secondary emission will be swept back to the first photoelectric surface,  $B'$ , there to cause the ejection of additional secondary electrons. This process may be continued indefinitely and if at each electronic impact several secondary electrons are produced, the original photoelectric image may be amplified many thousands of times after a few trajectories.

The foregoing description of the principles of a multipactor is a gross simplification. Actually the operation of the device is extremely complicated and many difficulties, several of which appear almost insurmountable, must be overcome before the tube will constitute a practical method of fluorescent amplification. Indeed the instrument at present is little more than an academic curiosity.

Considerable effort will be expended in the post-war era to explore the multipactor's intriguing possibilities. Investigations will also be conducted in other directions, and although it is not possible to predict when fluorescent amplification will become a practical reality, it may be sooner than some of the more pessimistic workers believe.

RUSSELL H. MORGAN





ADOLPH HARTUNG  
1883-1944

**A**DOLPH HARTUNG, a member of the American Roentgen Ray Society since 1912, died on May 29, 1944, of coronary stenosis. He was Professor of Radiology in the University of Illinois College of Medicine from 1925 on, where from 1909 he had been instructor. He was a charter member

of the Chicago Roentgen Society and was its president for two terms; a fellow of the American College of Radiology, a member of the Radiological Society of North America, and a diplomate of the American Board of Radiology.

Dr. Hartung was born February 26,

1883, in Gotha, Germany. When he was fifteen months old his family moved to Milwaukee, where he attended grade school and high school, after which they moved to Chicago. He became interested in the roentgen ray about 1900, as a demonstrator and salesman, and he demonstrated the rays at the Louisiana Purchase Exposition at St. Louis in 1904. In 1908 he received the degree of Doctor of Medicine from the College of Physicians and Surgeons in Chicago, later the Medical School of the University of Illinois, and had won election to Alpha Omega Alpha. He worked his way through school by serving as a pharmacist's apprentice, and while he had never attended a pharmacy class, he passed the examination qualifying him as a licensed pharmacist.

His early interest in radiology led him after a short period in general practice to resume that activity, and he was successively radiologist to the Alexian Brothers, Grant, Cook County, and University of Illinois Research and Educational Hospitals. He was a genial and informal person, ever the student in both his reading and writing. For several months before his death he knew that he had coronary disease but he chose to continue at work except for occasional short periods of being confined to the hospital; he could not give up to invalidism.

In 1919 Dr. Hartung was married to Miss Clara Henrici, who survives him, with two daughters, Hertha and Annette.

T. J. WACHOWSKI



# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer.*

## MEETINGS OF ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary*, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: 1945, to be announced.

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary*, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary*, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio.

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary*, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1945, to be announced.

#### RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

*Secretary*, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

#### SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

*Secretary*, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.

#### RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

*Secretary*, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

#### SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

*Secretary*, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

#### RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION

*Secretary*, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

#### RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

*Secretary*, Dr. Roy G. Giles, Temple, Texas.

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary*, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N. Y. Meets monthly on fourth Tuesday, October to April.

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

#### CHICAGO ROENTGEN SOCIETY

*Secretary*, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary*, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 p.m. at Allerton Hotel on fourth Monday each month, October to April, inclusive.

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary*, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 p.m.

#### DENVER RADIOLOGICAL CLUB

*Secretary*, Dr. Edward J. Meister, 366 Metropolitan

Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary*, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

#### FLORIDA RADIOLOGICAL SOCIETY

*Acting Secretary*, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary*, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

#### INDIANA ROENTGEN SOCIETY

*Secretary*, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meeting held the second Sunday in May annually.

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary*, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 p.m.

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary*, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

#### NEBRASKA RADIOLOGICAL SOCIETY

*Secretary*, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 p.m. at either Omaha or Lincoln.

#### NEW ENGLAND ROENTGEN RAY SOCIETY

*Secretary*, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

#### RADIOLOGICAL SOCIETY OF NEW JERSEY

*Secretary*, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

#### NEW YORK ROENTGEN SOCIETY

*Secretary*, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 p.m.

#### NORTH CAROLINA ROENTGEN RAY SOCIETY

*Secretary*, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

\* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

## NORTH DAKOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. L. A. Nash, St. John's Hospital, Fargo.  
Meetings held by announcement.

## CENTRAL NEW YORK ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse.  
Three meetings a year. January, May, November.

## OHIO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio.

Meets at time and place of annual meeting of Ohio State Medical Association.

## PACIFIC ROENTGEN SOCIETY

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

## PENNSYLVANIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. L. E. Wurster, 416 Pine St., Williamsport.

## PHILADELPHIA ROENTGEN RAY SOCIETY

*Secretary*, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

## PITTSBURGH ROENTGEN SOCIETY

*Secretary*, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

## ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

## ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

*Secretary* Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

## ST. LOUIS SOCIETY OF RADIOLOGISTS

*Secretary*, Dr. E. W. Spinzig, 2646 Potomac, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

## SAN DIEGO ROENTGEN SOCIETY

*Secretary*, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

## SAN FRANCISCO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Martha Mottram, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Toland Hall, University of California Hospital, second six months at Lane Hall, Stanford University Hospital.

## SHREVEPORT RADIOLOGICAL CLUB

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

## SOUTH CAROLINA X-RAY SOCIETY

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

## TENNESSEE RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

## TEXAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, January 17, 1945.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGEN-  
OLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

## UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

## VIRGINIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

## WASHINGTON STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

## X-RAY STUDY CLUB OF SAN FRANCISCO

*Secretary*, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

## CUBA

## SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

## BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH  
THE RÖNTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE  
(CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

## FACULTY OF RADIOLOGISTS

*Secretary*, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN  
MEDICAL CONGRESS

*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE  
BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

## CANADIAN ASSOCIATION OF RADIOLOGISTS

*Secretary*, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton, Alberta.

## SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL  
ASSOCIATION

*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

## SOUTH AMERICA

## SOCIEDAD ARGENTINA DE RADIOLOGIA

*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

## CONTINENTAL EUROPE

## SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-  
GESELLSCHAFT)

*Secretary* for French language, Dr. A. Grosjean La Chaux de Fonds.

*Secretary* for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

## SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

*Secretary*, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

## ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD:

USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

## LENINGRAD ROENTGEN RAY SOCIETY

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

## MOSCOW ROENTGEN RAY SOCIETY

*Secretaries*, Drs. L. L. Holst, A. W. Ssamygina and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

## SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.



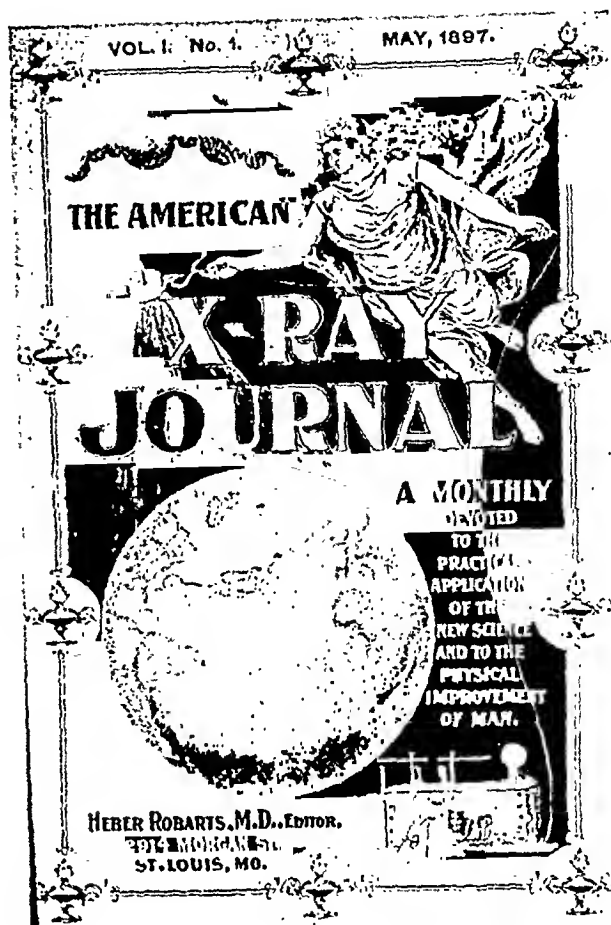
## A HISTORICAL NOTE ON ROENTGENOLOGIC LITERATURE

Having recently come into possession of Volume 1, No. 1 (Fig. 1) of the *American X-Ray Journal* which made its appearance forty-seven years ago, it seems worth while to publish some notice of this ancestor of the *AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY*.

The announcement of the advent of the *American X-Ray Journal*, written by Heber Roberts, M.D., Editor, contains many points which are sound even at this time (Fig. 2). The *American X-Ray Journal* was the second published in English and the first published in America. It was preceded by the *Archives of Skiagraphy* which was published in London in 1896.

FIG. 1. (right) Cover of the *American X-Ray Journal*.

FIG. 2. (below) Announcement of the appearance of the *American X-Ray Journal*.



## THE AMERICAN X-RAY JOURNAL.

A Monthly Journal devoted to Practical X-Ray Work and Allied Arts and Sciences.

VOL. I.

ST. LOUIS, MO., MAY, 1897.

No. 1.

THE AMERICAN X-RAY JOURNAL.  
PUBLISHED MONTHLY.

REARLY SUBSCRIPTION RATES IN ADVANCE.  
1 Year, \$1.00; 6 Months, 50c.  
Single Copies, 10c.  
Foreign Postage, 25c.  
HEBER ROBERTS, M.D., Editor,  
445 N. 3rd Street, St. Louis, Mo.

### ANNOUNCEMENT.

No apology is considered necessary for undertaking the publication of the *AMERICAN X-RAY JOURNAL*, the "first born" of its kind, and a journal in line with human thought and the practical needs of man.

Fifteen months have passed since the *Winning* professor first announced the discovery of the x-rays, and as great has the interest become that every item pertaining to the new science is grasped by the public press with avidity. The claims made by Professor Roentgen were received at the time with unmingled incredulity and contempt, and are even at this date not properly appreciated by some professional reading people.

The medical profession have a recent for amplifying, pinning, and utilizing new facts for the benefit of humanity and themselves, but in this instance there are financial, mechanical, and technical difficulties which must be surmounted by them before the x-rays can be practically applied. Again, inefficient apparatuses are everywhere used by exhibitors and furnish upon the attention of doctors. It is in recent of these facts that physicians do not readily adopt the new science,

notwithstanding the public clamor for its use.

The ease and certainty of diagnosing some surgical affections has advanced more in the past twelve months than any previous hundred years. In the first experiments with the x-rays it was thought possible to photograph only the bones of the hands, and this only after long exposure, while examinations with the fluoroscope were considered too tedious and impracticable. But the usefulness of the x-rays has so rapidly extended that no bone of the human body has escaped successful photography, and the bones have been examined directly with the fluoroscope. Successful work is being done also in diagnosing cases of cancer, tumors, appendicitis, gall stones, renal and urinary stones, expansion of the cranium and blood clots. In addition to the more common cases of fracture, dislocated joints, and the location of foreign substances in any portion of the body. In the fluoroscope the heart is observed and studied in its movements, the diaphragm is outlined and seen to rise and fall with respiration, and the visceral organs can be studied.

The application of the x-rays has been used with success in certain cases of the hand, in nervous twitching, tremulousness of the hands and body, and also the annoying rotatory movements of the eye-ball (nystagmus). Other avenues of inquiry have been opened for the x-ray application, notably cold abscesses within the body, degenerative germinal affec-

### THE AMERICAN X-RAY JOURNAL.

tion, especially consumptive disease, and the early diagnosis of this disease, and also the practical use of the x-ray in dentistry.

It is the design of this journal to give to teachers and thinkers a faithful résumé of all x-ray work done in any portion of the globe. The editor's personal experience with the x-rays for practical purposes, together with seventeen years of medical and surgical experience, offering many official hospital positions, and traveling through to search of medical facts, renders the task of inquiring x-ray information more appropriate for those who read and think. It is the intention of the promoters of this journal to give to the world only truthful results, with full credit to the experimenter in all its relations to the new science.

This field of inquiry must have associated with it practical and useful adjuncts. The most essential which shall occupy space are medico-legal jurisprudence, the therapy of electromagnetic science, preventive medicine, hygiene, dentistry, and collateral branches.

We shall favor correspondence with prompt criticism so long as it deals with the subject-matter of the journal.

No advertisements shall appear in the journal that savor of quackery, deception, or fraud.

Medical and scientific publications reflect the sittings of individual thought, and the press gives the practical side and utilizes the facts. Their work must be especially commendable and personal gratitude acknowledged.

The conduct of this journal shall not be arrogant, defiant, or bigoted, but it will have the courage of conviction to press forward the truth as we understand it. It will be ethical, as the theologists of every breast should be, regardless of any written code dictated by man for another's guide. There will be no personal venom, as we hold an animus against any man, but false principles will

be attacked with the vigor of our ability. This is a pioneer journal of x-ray work. We are not imitators. We are creating our hopes among the needs and wants of man. We expect encouragement.

While it can not be expected nor desired that we shall escape just criticism, and it may be continually, yet our aim shall be to improve each coming journal, encouraged as we are in the faith and meliorism of our mission.

HEBER ROBERTS, M.D., Editor.

### A PREMIUM OFFER.

The subscription price of the *AMERICAN X-RAY JOURNAL* is \$1.00 per year. With this price is included the character of the journal, a full and complete edition, we have made arrangements by which we can offer additional inducements to subscribers. We will send the *JOURNAL* free of charge and the following named books, pertaining to x-rays at the price shown below:

"A B C of the X-Rays" (price, 75 cents) and the *JOURNAL* for \$1.00.  
"The X-Ray of Photography of the Invertebrates" (price, 75 cents) and the *JOURNAL* for \$1.00.  
Both of the above books and the *JOURNAL* for \$1.25.

"Roentgen Rays and Photography of the Arthropod and Catfish" (price, \$1.50) and the *JOURNAL* for \$1.25.

These three books and richly illustrated, beautifully printed on coated paper, and handsomely bound in cloth.  
The great number of questions coming from the mail seeking information in regard to the x-ray have become too voluminous and too important for individual reply. We have concluded, therefore, to make a categorical text of these inquiries, and answer to each a brief answer or definition. Calculating from what we have now, and the probable result from general extended requests for further questions is a basis for judgment, we feel confident of being able to continue

The editor of the *American X-Ray Journal* was both the first and second president of the American Roentgen Ray Society founded in 1900. The office of the journal and of its editor was located at 2914 Morgan Street (now Delmar Boulevard) St.



FIG. 3. Home and office of Heber Robarts, M.D., Editor of the *American X-Ray Journal*. This house is located in the center of what is now the "blighted" district of St. Louis.

Louis, Missouri (Fig. 3). The photograph of this house indicates the descent of a neighborhood from one of relative affluence to one of abject poverty.

Few files of the *American X-Ray Journal* are in existence and many, if not most, radiologists are unaware of the existence of this publication important in its day. The great number of present day radiological publications obscures the significance of these early efforts.

From the meager beginnings at the time of Roentgen's discovery, November 8, 1895, there is now a world wide roentgenologic literature. The Army Medical Library in Washington lists thirty-five such journals.

SHERWOOD MOORE

## CANCER TEACHING DAY

On October 17, 1944, a Cancer Teaching Day was held at the Herman M. Biggs Memorial Hospital, Ithaca, New York, under the auspices of the Medical Society of the County of Tompkins, the Medical Society of the State of New York, and the Division of Cancer Control of the New York State Department of Health. The following papers were presented at the afternoon session: "Carcinoma of the Colon," by Dr. John H. Garlock, New York City; "Bone Tumors," by Dr. John J. Morton, Rochester, New York. At the evening session a paper was presented by Dr. Andrew H. Dowdy, Rochester, New York, on "Epithelioma of the Skin," and one by Dr. Frank E. Adair, New York City, entitled "Carcinoma of the Breast."

## OHIO RADIOLOGICAL SOCIETY

At the annual meeting of the Ohio Radiological Society the following officers were elected: *President*, Dr. Clarence E. Hufford, Cleveland; *Vice-President*, Dr. H. G. Reineke, Cincinnati; *Secretary-Treasurer*, Dr. Henry Snow, Dayton. *Members of the Executive Council*: Dr. Ralph Holmes, Chillicothe and Dr. John Newton, Cleveland.

## PITTSBURGH ROENTGEN SOCIETY

At the meeting of the Pittsburgh Roentgen Society held on May 10, 1944, the following officers were elected for the coming year: *President*, Dr. William J. McGregor, Pittsburgh; *Vice-President*, Dr. James R. Gemmill, Monesson; *Secretary-Treasurer*, Dr. Lester M. J. Freedman, Pittsburgh.

## ERRATUM

In the paper by J. J. McCort, C. N. Davidson and H. J. Walton entitled "Determination of the placental site in bleeding during the last trimester of pregnancy," in the August, 1944, issue of this JOURNAL, Vol. 52, pp. 128-135, the summary 5(c) on page 134 should read: "Widening of sacral promontory-fetal head distance when the placenta is implanted upon the posterior wall."

## BOOK REVIEWS

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*Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.*

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**MEDICAL PHYSICS.** Otto Glasser, Ph.D., Editor-in-Chief, Head, Department of Biophysics, Cleveland Clinic Foundation; Professor of Biophysics, Frank E. Bunts Educational Institute; Consulting Biophysicist, University Hospitals of Cleveland, Cleveland, Ohio. With 23 Associate Editors and numerous contributors. Paper. Price, \$18.00. Pp. 1744, with many illustrations. Chicago: The Year Book Publishers, Inc., 1944.

This is a compendium of information useful for the investigator in biological and medical sciences and informative to those engaged in specialized or general medical practice. The title of the book fails to express the catholicity of its scope, unless there be agreed that as a definition for the term "physics" there be adopted the earlier connotation of the Hellenic *φύσις* namely the science and principles of that existing materially in nature, including chemistry and biology. Only under such a broadened definition can it be understood why subjects such as ecology, chlorophyll, odor, hydrogymnastics, and gait, are included with roentgenography, electron diffraction, encephalography, centrifugation, electron microscopy, vacuum technic, and osmosis in living systems.

The foreword states a three-fold objective of the editor-in-chief: (1) an encyclopedia of all aspects of medical physics; (2) a textbook to serve students, and (3) a working instrument containing data for actual applications to medicine. The volume is indeed encyclopedic: it appears to be entirely unsuited for a textbook; it should be of aid in practice to those with adequate knowledge.

The general index is extensive; a classified table of contents supplementing the alphabetical table of contents doubtless reflects the selections of the 23 associate editors in the subgroupings of like number. There is an occasional strange inclusion in a sub-group as for instance "microphotography" under the heading "Anatomy," but in general, one can locate without too much difficulty one or more expositions with bibliographic citations on almost anything that he might include under the title of this

book, and much that is no less interesting and pertinent because it is unexpected. This is indeed a stimulating agglomeration of technical information and explanations of a melange of interesting and utilizable topics, most of which belong clearly in the realm of Medical Physics.

JOHN W. M. BUNKER

**SYMPOSIUM ON RADIOGRAPHY.** Held at the Thirty-ninth Annual Meeting, Atlantic City, N. J., June 30-July 1, 1936, and Forty-fifth Annual Meeting, Atlantic City, N. J., June 23, 1942, of the American Society for Testing Materials. Cloth. Price, \$4.00. Pp. 256, with 177 illustrations. Philadelphia: American Society for Testing Materials, 1943.

The medical radiologist who is interested in what is going on outside his immediate field will find this book worth while. Part of it, having to do with the roentgenography of massive cast or welded structures by the use of megavolt equipment is real entertainment for those who like to know what "the other fellow" is doing and can do, even though it is not applicable to the reader's own field. Other parts of the book, having to do with highly developed techniques in microradiography, for example, are applicable to the medical field as are some of the studies of light alloys wherein fine detail is brought out in spite of a range of thickness and density far beyond those encountered in the human body.

An interesting sidelight which makes a story in itself is the modern use of filters in roentgenography. Years ago, much work was done on the use of filters in medical roentgenography but with the development of the Bucky diaphragm nearly all of this work fell into the discard. The Bucky, however, is of little use in industrial work, while modern roentgen power-plants make it possible to use thin filters of high atomic number (also a modern development) to great advantage.

There is a chapter on protection, by Lauriston S. Taylor, of real practical use to anyone planning a new installation.

K. E. CORRIGAN

**ROENTGENOGRAPHIC TECHNIQUE: A MANUAL FOR PHYSICIANS, STUDENTS AND TECHNICIANS.** By Darmon Artelle Rhinehart, A.M., M.D., F.A.C.R., Professor of Roentgenology and Applied Anatomy, School of Medicine, University of Arkansas; Roentgenologist to St. Vincent's Infirmary, Missouri Pacific Hospital, and the Arkansas Children's Hospital, Little Rock, Arkansas, etc. Third edition, thoroughly revised. Cloth. Price, \$5.00. Pp. 471, with 201 illustrations. Philadelphia: Lea & Febiger, 1943.

As the author states in his preface, this is a thoroughly revised text of his manual on roentgenographic technique. Although the general plan of the book has remained unchanged, many recent advances made in this field have been added. The essential physics of roentgenography are covered quite adequately and outlined in such a manner as to be readily understood and absorbed by the beginner. Many students entering a training course in roentgen technology as high school graduates without additional college experience are having their major difficulty with this aspect of the course. Yet it is very important for them to master the fundamental physics since the knowledge of what is happening "behind the controls" distinguishes the true technician from a mere robot. There are a few minor flaws in the book—as, for instance, the right part of Figure 191—however, they do not detract in any way from its value as a guide for those for whom it was written. The fact that it appears now in its third edition speaks for itself.

ERNST A. POHLE

**ABRIDGED SCIENTIFIC PUBLICATIONS FROM THE KODAK RESEARCH LABORATORIES.** Paper. Pp. 391, with numerous illustrations. Rochester, New York: Eastman Kodak Company, 1943.

This is a compilation of sixty papers published during 1942 by members of the Kodak

Research Staff. The major portion of the papers are concerned with advanced organic chemistry. Also included are: a paper (No. 840, page 163) by D. L. MacAdam, "Visual sensitivities to color differences in daylight," of considerable interest to anyone studying color response of the eye; a "general interest" paper on color photography (No. 832, page 121) by C. E. K. Mees; and a number of papers on the physics of solutions.

K. E. CORRIGAN

**INFECTIONS OF THE PERITONEUM.** By Bernhard Steinberg, M.D., Director of Toledo Hospital Institute of Medical Research; Past Fellow of the National Research Council; Former Crile Research Fellow, Western Reserve University. With a Foreword by Frederick A. Collier, M.S., M.D., Professor of Surgery, University of Michigan Medical School; Director, Department of Surgery, University Hospital, Ann Arbor, Michigan. Cloth. Price, \$8.00. Pp. 455, with 44 illustrations. New York: Paul B. Hoeber, Inc., 1944.

This is a refreshing and instructive book by a man who has spent eighteen years working on the problem of peritoneal infections. He has made many important contributions to our present day knowledge of the condition. Anyone, surgeon and practitioner alike, concerned with the diagnosis and treatment of peritonitis in its many phases will profit by a careful consideration of the material presented. The author presents new concepts regarding developmental mechanism, diagnosis and treatment. The pathology and its associated disturbance of physiology and chemistry are stressed. The bibliography is exhaustive. Conflicting opinions involving therapy are commented upon and evaluated. The major portion of the book is clinical in nature, including case studies to illustrate the material presented. I know of no comparable volume on the subject.

LLOYD W. STEVENS



## DEPARTMENT OF TECHNIQUE

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# A DEVICE FOR MEASUREMENT OF HEART SIZE IN MINIATURE ROENTGENOGRAMS AND A SUBSTITUTE FOR TELEROENTGENOGRAPHY AND ORTHODIASCOPY

By RICHARD GUBNER, M.D., and HARRY E. UNGERLEIDER, M.D.

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NEW YORK, NEW YORK

MINIATURE roentgenograms of the chest, either 35 mm. or 4×5 inch size, made by the fluororoentgenographic technique (photography of the fluoroscopic screen), are now generally employed in surveys in the armed forces, institutions and industry. Measurement of the size of the heart cannot be accomplished directly because of the reduced size of the cardiac shadow, and also because miniature films are exposed at shortened focal distance, with consequent appreciable projection magnification.

The simple procedure illustrated in Figures 1 and 2 makes possible the exact measurement of the size of the heart, so that early enlargement may be recognized employing accepted standards for the transverse diameter and frontal cardiac area.\* A lead scale with markings at 0.5 cm. intervals is placed alongside the patient in the plane of the anterior axillary line. The scale is recorded on the roentgenogram when the chest exposure is made. The photograph of the scale on the miniature film serves as a reference for measurement of the cardiac shadow, and the cardiac diameters may be read off directly on the scale employing a caliper. Since the scale is suspended in the anterior axillary line in the same plane as the contours of the heart, the projection magnification of the heart and the scale are practically identical.

\* Ungerleider, H. E., and Gubner, R. Evaluation of heart size measurements. *Am. Heart J.*, 1942, 24, 494-510.

This method is equally applicable for the conventional 14×17 inch roentgenogram and makes unnecessary the use of teleroentgenographic (2 meter) distance, which requires high power equipment for desirable short exposures. In roentgenoscopy the orthodiascopic method may be employed to eliminate projection magnification, which is considerable because of the proximity of the tube to the fluoroscopic



FIG. 1. A lead scale suspended parallel to the cassette in the plane of the anterior axillary line is recorded on the roentgenogram. Projection magnification is of the same order as the heart, and reduction in miniature roentgenograms is likewise identical. The scale recorded in the roentgenogram serves as reference for cardiac measurement.



FIG. 2. Scale with 0.5 cm. markings recorded on 14×17 inch roentgenogram as shown in Figure 1. Insert shows fluororoentgenogram of same subject recorded on 35 mm. miniature film at 3 ft. distance. Transverse diameter is same with both techniques (12.0 cm. in 14×17 inch roentgenogram, 11.9 cm. in 35 mm. miniature film).

screen. Orthodiascopy requires a special attachment, permitting the roentgen tube to be moved independently of the screen, the central ray (indicated by a lead marker) being used to trace the outline of the heart. The orthodiascopic technique requires training and exact application for precision, since there is a large subjective element. The use of the lead scale, as indicated in Figure 1, permits accurate measurement of the size of the heart on ordinary roentgenoscopic examination without the need of specialized apparatus as required in orthodiascopy.

The scale may be suspended in proper position in several ways. It may be mounted to slide on two horizontal bars attached to

the cassette or screen by suction cups (Fig. 1), or it may be attached in the anterior axillary line with adhesive tape, suspended by a shoulder strap, or mounted on a floor stand. It is important that the scale be parallel to the cassette to avoid foreshortening of the image, and that it be placed correctly in the anterior axillary line.

#### SUMMARY

A method is described for the accurate measurement of the size of the heart in miniature roentgenograms. This method serves also to obviate the need of teleroentgenography and orthodiascopy for elimination of projection magnification in the roentgenogram and roentgenoscopic image.

# RADIUM CONTAMINATION OF ROENTGEN FILMS

By ROBERT B. TAFT, M.D., B.S., M.A., F.A.C.R.

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THE finding of unexplained black spots on roentgen films was very annoying during normal times but during the present film shortage it is a serious matter. In medical roentgenograms the spots are generally recognizable as artefacts but in industrial roentgenography they are easily confused with defects in castings and weldings. Figure 1 shows such a spot, which was the largest encountered, though a large number of slightly smaller ones have been found. These spots have been proved to be the result of small quantities of radium salts incorporated in the cardboard of which the film box is made.

I first noticed these spots in March, 1942, on the films of one of the leading companies. All of the films in a box showed these spots and in the same location but the films in one side of the box showed the spots to be of much greater density. Many of the films were usable but others were so badly marked that additional roentgenograms had to be made with films from another source.



FIG. 1. Film spot due to small particle of radium salt incorporated in the cardboard box containing the films.

In 1939, a radiologist had the misfortune to break a 10 milligram tube of radium sulfate which resulted in many of the articles in his office being contaminated with fine particles of radium salt. I was asked to make tests on the materials and found that the cassettes had been sprinkled with mi-

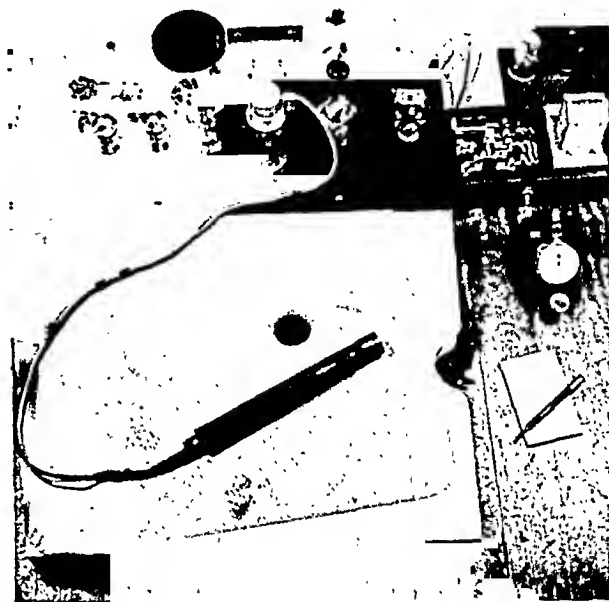


FIG. 2. A film developed without exposure serves as a guide to the placing of the Geiger-Müller counter tube on the exact part of the box containing the radium particle.

nute particles which gave a blackened spot on the roentgen film after they had been in close contact for several days.

The appearance of the spots on the roentgen films recently seen were so similar to those caused by the minute particles of radium that I undertook to determine if these spots could be caused by similar materials. As a result, the boxes in question were torn up and new films in light-tight containers were clamped against the cardboard for several days at a time. Following standard development, the characteristic spots appeared on the new films.



As many as thirty such spots have been seen on a single 14×17 inch film but most of them are comparatively small, though the one shown in Figures 1 and 2 is of such intensity that most of the films in the half gross box had to be discarded.

Occasionally a spot will have the shape of a dumbbell; however, this is not the result of two radioactive particles but of the films having been at rest for several months and then the box receiving a sudden jolt caus-

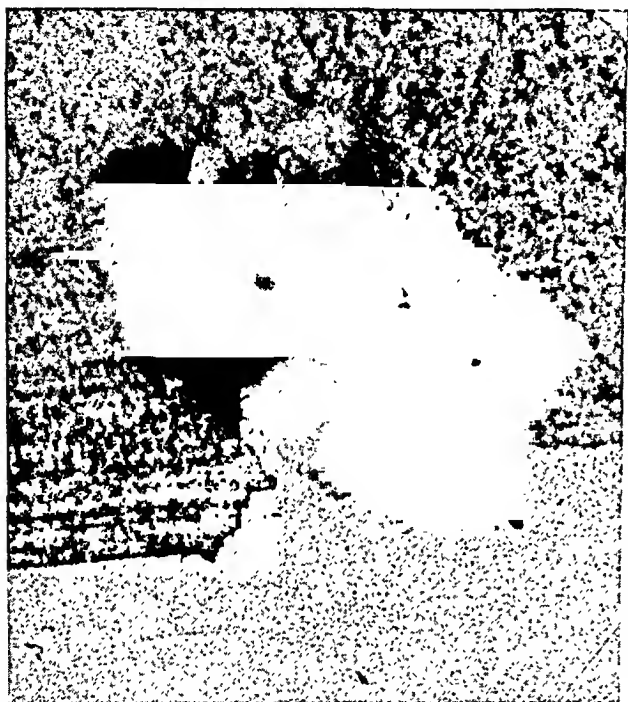


FIG. 3. Combination autoradiograph and photograph enlarged 14 diameters to show the exact location of the spot in the section for microscopic study.

ing the films to shift to a slightly different position.

The possibility that these boxes had been contaminated by radium dust in my office is eliminated by the fact that the same conditions were encountered in several boxes at a hospital where there is no radium.

The final proof that these spots are caused by radioactive material is obtained from the Geiger-Müller counter which shows the presence of gamma radiation. As shown in Figure 2, the spot is first localized by superimposing the film on the box, then the counter tube is placed as close as possible to it. Repeated counts, as well as con-

trols on the boxes which showed no spots, demonstrate the undeniable effect of radioactive material.

Precision measurements on a radioactive particle of this size offer many difficulties but measurements made in different ways all showed a radium equivalent of approximately 0.0005 microgram in the particle shown in Figures 3 and 4.

The manufacturers were most generous in their replacement of defective films but admitted their complete inability to determine the cause. One manufacturer eliminated the difficulty by obtaining the cardboard boxes from another source. Recently, having found more of these spots, I attempted to determine the type of offending material and to learn a method by which it may be eliminated before the films are put up in the boxes.

A known location in a box having been proved radioactive by the Geiger-Müller counter, exact localization was accomplished by placing films on each side of the card, then cutting out a small circle (about 9 mm.) and testing this. Most of these tests took an exposure of about twenty-four hours but when thinner sections were made of the circle of cardboard, an exposure of an hour was sufficient. A strongly radioactive spot was finally located in the middle of a section approximately 0.48 mm. in thickness. As hand-cutting could not be done further, this piece was embedded in paraffin and cut with a microtome into sections 20 microns thick. These sections were then laid out on slides, covered with cellophane, and strips of film placed on them. A five minute exposure showed that one section contained most of the material, another a small amount and a third showed faint trace. The problem was then to determine the exact location of the radioactive spot in the section, as microscopic examination showed only miscellaneous material. The section was placed in a printing frame with roentgen film on the bottom and, after a five minute exposure, light was flashed on the frame which gave a photographic silhouette of the section. This photograph-



FIG. 4. Colored drawing showing remarkable contrast of the radioactive spot against the other material of the cardboard, as seen by near ultraviolet light. Fourteen diameter enlargement.

radiograph, enlarged about 14 diameters, is shown in Figure 3 and permits exact localization. In this spot a small pile of pale green crystals could be seen. The appearance and gamma-ray activity was similar to radium luminous paint. It was far more active than uranium oxide, or carnotite.

Subsequently, a much simpler method of location has been found; that is, observation under near ultraviolet radiation from the BH<sub>4</sub> lamp. Figure 4 is a colored drawing of this slide under a 14 power microscope. The intensity of color is no exaggeration; in fact, this spot stands out so clearly that without any magnification it can easily be seen at a distance of 10 feet. Nothing else has been found in the card that fluoresces appreciably.

How this substance gets into the paper mash will probably remain a mystery but inspection of the mash under ultraviolet light is so simple that the manufacturer can inspect many square yards of it at a glance, and possibly reach the source of contamination. To the radiologist who encounters this condition, the suggestion is offered that

films be immediately removed from the box in order to prevent further blackening.

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#### ADDENDUM

It was stated above that one manufacturer eliminated the difficulty by obtaining cardboard boxes from a different source but since this paper was written, numerous spots have been found showing that the second source was contaminated also.

Information recently received from the DuPont Company is that in the dial painting industry the brushes are now wiped on tissue paper instead of in workers' mouths, as was done in the old days. The tissues frequently find their way in with other waste paper and subsequently become cardboard boxes.

For the above reason, it is doubtful if occasional spots of this kind will ever be completely eliminated.

Furthermore, the film manufacturers claim that as they have no control over the manufacture of cardboard they are unable to carry out the idea of having the mash inspected by black light.



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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN AND RADIUM THERAPY

WINDEYER, B. W. Radiation reactions. *Brit. J. Radiol.*, Aug., 1942, 15, 236-237.

The basal cells of the skin are more sensitive to irradiation than the prickle cells and squamous cells. The prickle and squamous cells are not renewed when the basal cells are destroyed by irradiation and the skin becomes thinner until finally there is desquamation down to the basement membrane.

The two chief points in the treatment of radiation reactions is the control of infection and the elimination of trauma. The tannic method of treatment of thermal burns has not proved as effective for radiation burns. Another method of treating thermal burns is that of irrigation with electrolytic sodium hypochlorite in the Stannard oiled silk envelope. This method is also very comfortable for radiation reactions and brings about rapid healing and a minimum of scarring. It is effective even in post-irradiation buccal necrosis which is one of the most difficult post-irradiation conditions to treat.

Connective tissue reactions vary greatly even when the same dose of irradiation is used. Two cases of carcinoma of the larynx may be treated with the same dose and one will progress normally while increasing edema of the arytenoids may develop in the other. In the latter results are apt to be very unsatisfactory no matter what changes in technique are adopted. The cause of this difference is not known.—*Audrey G. Morgan.*

ELLIS, F. Volume dosage in deep x-ray therapy.

The estimation of volume dosage in deep x-ray therapy for clinical purposes. Part II. The correlation of biological effects with volume dose. *Brit. J. Radiol.*, July, 1942, 15, 194-201.

A study is made of the relationship between volume dose and biological effects. Tables and graphs are given showing the effect of varying volume doses on the blood picture. Accurate correlation is impossible, however, as the graphs vary greatly in form, and quantitative and even qualitative changes in the leukocyte picture are not uniform for given volume doses. The

number of cases examined was limited, however, and it is possible that with larger numbers of cases more uniform results would be obtained.

Experiments are also described in the use of histaminase and ascorbic acid in the treatment of irradiation sickness. So far the author's experience indicates that histaminase is more effective for this purpose than ascorbic acid.—*Audrey G. Morgan.*

FARMER, F. T. A direct-reading radon meter for clinical purposes. *Brit. J. Radiol.*, Nov., 1942, 15, 318-319.

Radium, on account of its cost, must be measured very accurately. But radon seeds degenerate quickly and therefore the need in measurement is rather for quickness and simplicity with a sufficient degree of accuracy for clinical purposes.

An instrument for such measurement is described and illustrated with a photograph and a diagram. It consists of an ionization chamber and an electrometer valve system so that any source of gamma rays applied to the chamber can be read directly on the scale of a meter in the anode circuit. By controlling the voltages supplying the valve carefully it can be kept constant enough and it is not necessary to use substitution of a standard potential source as in more accurate measurements. It is operated from batteries, one of about 100 volts supplying the anode and chamber, and a 2-volt accumulator feeding the filament. Both are small and readily portable. Calibration is by means of radium tubes of known strength. It is accurate to within 2 to 3 per cent which is sufficient for practical purposes.—*Audrey G. Morgan.*

ELLIS, FRANK. Tolerance dosage in radiotherapy with 200 kV x rays. *Brit. J. Radiol.*, Dec., 1942, 15, 348-350.

From published work and his own clinical experience the author concludes that there is such a thing as resistance on the part of the tissues to malignant disease. The optimum dose is the dose that will just allow the normal tissues to return to normal after irradiation, as that will inflict the maximum damage on the

malignant cells and enable tissue resistance to be utilized to the maximum degree. The tolerance dose means the dose that is tolerated by connective tissue, which is the tissue responsible for resistance and repair. Except in certain regions, such as the nervous system and bone, this is similar to the tolerance dose of the skin. Therefore the tolerance dose for the skin represents the optimum dose for treating malignant tumors. It is more important to preserve the resistance of the connective tissue bed of the tumor than it is to give a definite dose to each malignant cell.

A table is given showing a system of tolerance dosage produced at 200,000 volts constant potential and used mostly at 40 cm. distance with a filter of 1 mm. copper and 1 mm. aluminum. By continued accurate observation and the collaboration of other radiotherapists he hopes that corrected tables of this kind can be worked out. He also gives doses for inflammation and sterilization.—*Audrey G. Morgan.*

WILSON, C. W. The combination of radiation fields in deep x-ray therapy. *Brit. J. Radiol.*, Dec., 1942, 15, 355-359.

Much of the success of radiation therapy depends on the distribution of radiant energy by suitable arrangements of the beams based essentially on the dose contours of the beams. Desjardins says that the anatomical arrangement of the treatment is more important than the quantity of radiation given to any one field.

Any focus of disease should be irradiated with a dose which is as uniform as possible over the whole site and it should be as large a fraction as possible of the maximum dose given to any of the skin areas through which the beams pass. If the distribution of the irradiation is satisfactory it lowers the amount that need be given to any skin area. The dose delivered to diseased tissues should not be exceeded by the dose to any normal tissue within the irradiated area.

Illustrative dose contours are given for the treatment of cancers of the larynx and lung. Irradiation should be given from two opposite lateral fields and in some cases from a third posterior field. In the cases illustrated the factors were: 200 kv. (peak) (Villard circuit), 30 ma., focus skin distance 50 cm.; Thoraeus filter; half-value layer 1.63 mm. copper; fields 6×8 and 10×8 cm. The conditions of dose and scatter used in treatment should be as nearly as pos-

sible equivalent to those under which the dose contours were originally determined. This method involves more work than the usual one but this is much more than compensated for by the better results obtained.—*Audrey G. Morgan.*

WILLIAMS, I. G. Very high voltage x-ray therapy (supervoltage). *Brit. J. Radiol.*, Dec., 1942, 15, 360-364.

In 1938 and 1939 the author visited roentgen clinics in the United States, and in this article he examines the claims made in regard to the superiority of high voltages (400 to 1,200 kilovolts) as compared with 200 to 250 kv. treatment. Depth dosage curves are given which show that between 400 kv. and 900 kv. backscatter increases by 6 per cent and depth dose by 5 per cent for a field 10×10 cm. in size. The principal factor that limits increase of dosage is the mucosa rather than the skin as in 200 kv. therapy. It has not yet been proved that the higher voltage rays have a different biological effect than the lower ones. Radiation sickness is less severe with the higher voltages than the lower. It is easier to maintain body weight on account of decreased nausea and vomiting. Within therapeutic doses the higher voltage radiation does not injure the blood-forming organs. There are better palliative results in advanced malignancies of the skin, uterus and prostate and in large clinics where a great variety of malignant tumors are treated the range of usefulness of roentgen therapy will probably be increased by the use of high voltage rays.

A bibliography is given of the work of the American radiologists and physicists consulted.—*Audrey G. Morgan.*

MACCARTY, WILLIAM C., and LEDDY, EUGENE T. Roentgen treatment of inoperable ulcerating carcinoma of the breast. *Radiology*, Dec., 1942, 39, 711-714.

One of the most distressing features in cases of inoperable carcinoma of the breast is ulceration. A study of case histories showed that the development of this stage is usually due to neglect of early treatment. From 1925 to 1940 inclusive the authors treated 98 patients with primary inoperable ulcerating carcinoma of the breast in the Section of Therapeutic Radiology at the Mayo Clinic. Forty of these patients had not gone for treatment before coming to the

clinic. The remaining 58 had not gone to a physician until they had had symptoms for an average period of 15.5 months. Of these 25 were given sound advice by their family physicians while the other 33 were given unsound advice, such as treatment with salves, pastes, lights, electricity, etc.

While any treatment of these cases is necessarily only palliative, the authors have found marked alleviation from roentgen treatment by the multiple converging beam technique. In the majority of cases they use 130 kv. (constant potential), 6 ma., 40 cm. target-skin distance and 6 mm. aluminum filtration. The anterior part of the thorax on the affected side is divided into four or six sectors, each sector centered over the tumor. The central rays are directed toward the center of the sector. If there are metastatic lesions they are treated as required. A dose of 500 to 600 r, measured in air, is given to each sector at one sitting. Usually treatment is given to one area or perhaps two daily; the full course may require from four to eleven treatment days. The series is repeated in a month and again after another month and later treatment given as indicated.

At the end of 1940, 43 of the patients were dead; there was no follow-up report from 24 but they were also probably dead. Twenty-four patients were living and said that they were definitely improved, while only 7 said that they were worse. There was the greatest number of improvements in the patients who had three or more courses of treatment, the fewest in those who had only one. After one course of treatment the average duration of life from the first treatment was slightly less than seven months while after three courses of treatment it was slightly more than a year and a half.—*Audrey G. Morgan.*

LEDERMAN, M., and MAYNEORD, W. V. The radium treatment of cancer of the vagina. *Brit. J. Radiol.*, Nov., 1942, 15, 307-312.

Primary cancer of the vagina constitutes only about 1 to 2 per cent of tumors of the female genital tract. Metastatic cancer is much more frequent. Treatment of these cancers has not heretofore been very successful because of their rarity and the lack of experience that any physician could acquire, because of the vascularity of the region and the advanced stage of the disease when the case is generally seen.

The best method of treatment is the local application of radium followed by teleradium

or high voltage roentgen treatment to the lymphatic areas of the pelvic and inguinal regions. In radium treatment the size and shape of the applicators must be adapted to the case, the applicators must be fastened firmly in position and the surrounding normal tissues must be adequately protected. A detailed description is given of the making and application of a urethral tube and vaginal applicator for use in this treatment and curves given showing the distribution of radiation around the tube and applicator. As the urethral tube is used to stabilize the applicator the patient must be anesthetized and to avoid the risk of infecting the bladder if the treatment is frequently repeated, treatment should be given two or three times, separated by intervals of two or three weeks. Sometimes in addition to this treatment groups of needles must be implanted at the base of the bladder. The radium treatment is followed by teleradium or high voltage roentgen treatment to clear up what is left of the primary disease and to irradiate the lymphatic areas.—*Audrey G. Morgan.*

SCHMITZ, HERBERT E., SHEEHAN, JOHN F., and TOWNE, JANET. The effect of preoperative irradiation on adenocarcinoma of the uterus. *Am. J. Obst. & Gynec.*, March, 1943, 45, 377-390.

The technique for the treatment of carcinoma of the uterine fundus by combined roentgen and radium therapy as employed at the Mercy Hospital Institute of Radiation Therapy is as follows: All patients are curetted and a Y-capsule containing 50 mg. of radium element in each arm is immediately inserted into the uterine cavity. The capsule is removed after 2,000 mg-hr. This dose is repeated on the eighth and sixteenth days giving a total radium dosage of 6,000 mg-hr. On the days that the radium is not in the uterus the patient receives roentgen therapy. The dose attained within the pelvis after twenty-eight days is 4,000 roentgens, with backscatter.

A group of 77 proved cases of adenocarcinoma of the uterine fundus has been studied. Eleven patients receiving preoperative irradiation were hysterectomized. Five of the uteri adequately treated (as outlined above) were free of carcinoma. Serial blocks of 4 of these 5 uteri failed to reveal residual carcinoma. The remaining 6 patients considered as inadequately treated all had active carcinoma remaining in the uterus.



Twenty-seven cases, irradiated but not hysterectomized, added further evidence as demonstrated by curettage or follow-up that adequate irradiation in clinical Group I or II carcinoma of the fundus has a definite value. Although the authors do not advocate their treatment as a substitute for surgery in patients who are good surgical risks, they feel that their plan of pre-operative irradiation should be carried on until sufficient case records are on hand to determine whether the five year survival rate is greater than in cases treated by surgery and postoperative irradiation.—*Mary Frances Vastine.*

RONGY, A. J., and SELEY, A. D. Radium therapy in benign uterine bleeding; study based on 350 cases. *Am. J. Obst. & Gynec.*, March, 1943, 45, 390-401.

Broadly conceived, surgery is but an admission of the shortcomings of medical science. The greater the progress of the science of medicine, the less will be the need for surgical intervention. Intrauterine irradiation, used in properly indicated cases, will reduce the operative incidence in patients suffering from uterine bleeding, with or without fibroids, in about 35 per cent. The authors feel that 1,800 mg.-hr. is the appropriate dose for women aged forty years or older. They insert 25 mg. in the uterus to be left seventy-two hours. They conclude:

(1) Uterine bleeding can be cured by curettage and intrauterine insertion of radium in properly selected cases.

(2) In 285, or 81 per cent of the patients studied, the bleeding was accompanied by fibroids; in 65, or 19 per cent, no fibroids were present.

(3) Complete involution of the tumor took place in 81.4 per cent of the cases and partial involution in 16.8 per cent. In 5 patients, the tumor was not affected by the radium.

(4) Radium is contraindicated in cases in which the uterus is enlarged to more than fourteen weeks' pregnancy. It should not be used when a submucous fibroid is suspected nor is its use advisable in subperitoneal or broad ligament fibroids.

(5) It is dangerous to use radium in patients who give a history of having had a pelvic infection.

(6) The menopausal syndrome is not accentuated by radium.

(7) Leukorrheal discharge is increased for a period of six to seven weeks in many cases.

(8) Sexual relationship is less likely to be disturbed following the use of radium than with surgery. The libido is definitely not affected.

(9) Curettage and intrauterine irradiation can be safely utilized in at least 35 per cent of patients suffering from uterine bleeding. It should replace abdominal hysterectomy in 25 per cent of cases and vaginal hysterectomy in 40 per cent.

(10) Curettage and radium therapy should be performed by gynecologists, not by radiologists.—*Mary Frances Vastine.*

BUSCHKE, F., and CANTRIL, S. T. Roentgen therapy of carcinoma of the urinary bladder; analysis of fifty-two patients treated with 800 kv. roentgentherapy. *J. Urol.*, Oct., 1942, 48, 368-383.

This report is a summary of 52 cases of carcinoma of the urinary bladder treated over a six year period with 800 kv. roentgen therapy. Thirty of these cases were treated with a current of 10 ma., a filter of 4.5 mm. of lead, skin-target distance of 70 cm., and an intensity of 60 r per minute. The remaining cases were treated at a skin-target distance of 100 cm. with an intensity of 25 r per minute. The areas treated were essentially a central suprapubic, a central posterior, left and right sacrals and an occasional perineal field which was treated with 200 kv. and 2 mm. of copper filtration.

Five of the 52 cases were free from disease cystoscopically after five years and 2 other cases for more than one year. The dosage varied from 6,000 r, measured in air, delivered to two fields to 17,000 r delivered to four fields. The treatment period varied from thirty to sixty days.

The authors give the following reasons for failure to control the majority of cases in this series: invasion of the muscular bladder wall by the tumor; technical errors in treatment such as limiting the field to too small an area, or too intensive or insufficient treatment; attempting to treat cases in which the disease process was too extensive; poor general condition of the patient, resulting in inadequate dosage or spacing of dosage over too long a period of time, and, finally, complications from previous therapy such as breaking down of a suprapubic scar. The authors give case reports illustrating these various reasons for unsatisfactory results.

They conclude that all papillary tumors of the bladder which are of a type tending to recur

or which have recurred once following fulguration should receive roentgen therapy as the procedure of choice at once, if at all. In cases of infiltrating tumors they feel that resection is the procedure of choice, if feasible. Contraindications to intensive roentgen therapy include poor general condition of the patient, inadequate bladder drainage, inadequate bladder capacity, and the presence of marked secondary infection.—*R. M. Harvey.*

RANDALL, LAWRENCE M., and BUIE, LOUIS A. Factitial proctitis. *Am. J. Obst. & Gynec.*, March, 1943, 45, 505-512.

"Factitial proctitis" is a term used to designate the changes sometimes incurred in the wall of the rectum when the pelvic viscera are treated by radium or roentgen rays. (The term "factitial" is defined in Dorland's Dictionary as "produced by artificial means; unintentionally produced.") Usually this lesion appears on the anterior wall of the rectum but in severe cases all walls may be involved. It varies in severity from mild inflammation of the rectal mucosa to complete dissolution of a portion of the rectovaginal septum.

*Pathology and Diagnosis.* Factitial proctitis, not associated with formation of ulcer, cannot be detected by palpation. The factitial ulcer averages from 1 to 3 cm. in diameter and is usually single. The inflammation and ulceration have a tendency to heal and if the carcinoma does not terminate the patient's life the lesion usually will undergo resolution.

*Symptoms.* In 88 cases studied, bleeding was the most frequent symptom. Other complaints in order of frequency were: frequent desire to go to stool, liquid stools, pain in the rectum, mucous discharges, and constipation. The average time that elapsed between the initial course of treatment and appearance of symptoms was ten months.

*Results of Examination.* The average location of the factitial proctitis was 9 cm. above the dentate margin. In 6 of the 88 cases, the involvement was diffuse and in the remainder it was circumscribed and located on the anterior wall of the rectum. In 25 cases reduction in the size of the rectal lumen was noted. There were 3 rectovaginal fistulas and they were 5 to 6 cm. above the dentate margin.

*Results.* Of the 30 patients who were followed from eight months to thirteen years, 25 noted marked improvement in the rectal symptoms after the acute stage. Most of them experi-

enced occasional bleeding from the rectum, some a tendency to constipation and one stated that the stool was reduced in size.

*Treatment.* Healing will usually take place providing the patient survives the malignancy for a sufficient time. In cases in which strictures develop obstruction will not occur unless extension of the cancer has been the cause of this stricture. Considering the very small percentage of patients treated with irradiation whose normal tissues sustain significant damage, and the gradual improvement in results following such treatment, it seems that factitial proctitis and ulceration (and the occasional rectovaginal fistula) must be accepted as risks that the patient should assume when such treatment is undertaken.—*Mary Frances Vastine.*

### MISCELLANEOUS

BRADFORD, DONALD. A belated review. *Brit. J. Radiol.*, Aug., 1942, 15, 224-227.

This is a review of a book published in 1896, soon after the discovery of x rays by Roentgen in December, 1895. It was not written by a roentgenologist but by a schoolteacher, Arthur Thornton, M.A., who was a teacher in one of the provincial grammar schools. It shows the great interest aroused in all scientifically minded people by the discovery of the rays. Curiously enough, many of the modern developments in roentgenology were forecast at that early date and the early theories discussed in the book are strikingly like those generally accepted today. For example the ionization measurement of intensity is generally thought to be quite modern but Thornton describes a method which established the property of ionization. At that time biological effects were not realized, however, and there was no reference to any precautions being necessary in handling the rays. Several pages of the book are reproduced.—*Audrey G. Morgan.*

BARCLAY, A. E. The passing of the Cambridge diploma. *Brit. J. Radiol.*, Dec., 1942, 15, 351-354.

The *British Medical Journal* for November 29, 1941, carried a notice that the courses leading to the Diploma of Medical Radiology and Electrology given at Cambridge would be discontinued and no further diplomas would be granted after October 31, 1942. This article reviews the early history of radiology when it was considered largely a branch of photography

and useful in medicine only in diagnosing fractures and localizing foreign bodies up to the present time. At the beginning of World War I roentgenological knowledge and practice were not very far advanced and the war brought about chaotic conditions. An army x-ray committee was set up and the leading radiologists worked untiringly to establish better conditions. After the war the need for more thorough training in this branch was recognized and discussion of the matter led finally to the establishment in March, 1919, of the course for the Diploma, the first part to be the study of physics and elementary radiology to be given in Cambridge and the second part to be clinical work in London. Credit is given to this course and the devoted work of the leading radiologists in teaching for much of the phenomenal progress in radiology that has been made since that time.—*Audrey C. Morgan.*

TEALL, C. G. A regional radiodiagnostic service. *Brit. J. Radiol.*, Oct., 1942, 15, 289-292.

In post-war planning the author thinks there should be an effort to bring about better co-operation between the voluntary and municipal hospitals. Both these classes of hospitals have heretofore treated only the poorer classes of the population while those better provided for were obliged to depend on nursing homes, not nearly so well equipped. It is now proposed to raise the income limit for National Health Insurance to 420 pounds sterling per annum which will embrace about 90 per cent of the population of the country. With hospital service available to so large a percentage of the population it will hardly be possible for a radiologist to support private equipment.

A suggestion is made that the country be divided into regions and these into divisions. Each region will have a key hospital and the divisions smaller hospitals serving the communities. Each regional hospital will have a radiological staff, the junior members of which can be sent out to the smaller hospitals when occasion requires. The most expensive and elaborate equipment will also be installed in the regional hospitals and simpler equipment will suffice for the smaller hospitals. There will be a transportable van equipment which can be carried to the homes when necessary. The Public Health Service will provide for mass examination in tuberculosis. In this way all the needs of all the communities in the country will be pro-

vided for, whereas at present there are many small communities that have no radiological service at all.—*Audrey G. Morgan.*

JEFFERSON, GEOFFREY. The problems of post-war reconstruction in radiology; the future of the specialties. *Brit. J. Radiol.*, Oct., 1942, 15, 283-285.

Hospitals grew up from the charitable motive of caring for the sick and wounded and as a result were adapted entirely to the needs of general medicine and surgery. But as science has developed, a number of specialties have arisen each of which requires time, space and money. The hospital of the future will probably be a Hospital Center with a number of specialist departments around a nucleus of general medicine and surgery, the latter to be used chiefly for the training of medical students. The student must get a balanced training without overemphasis on any one specialty. Yet as a matter of fact at the present time most physicians and surgeons are more or less specialists. For instance the general surgeon is for the most part an abdominal specialist and the student is led to believe that gallstones and stomach diseases are the chief things to be considered in surgery. In the properly balanced hospital of the future more time and space will be allotted the specialist and less to the general physician and surgeon.—*Audrey G. Morgan.*

HODGSON, H. K. GRAHAM. Radiological education of the future. *Brit. J. Radiol.*, Oct., 1942, 15, 292-293.

The author believes that the present nine months course required for a diploma in radiology is far too short and that too much of it is devoted to physics. He thinks that a two years course should be required and that the first six months should be devoted entirely to refresher courses in anatomy, physiology, pathology and clinical methods. The next twelve months should be spent in a roentgen-ray department in the study of radiology and roentgenography, separate courses being given for the students of diagnosis and therapeutics. During the final six months he should correlate what he has learned of roentgen appearances with the clinical and pathological facts seen in the operating room, wards and postmortem room. During these six months he would be a clerk or registrar to the roentgen department and act as a liaison officer between the roentgen department and the

other members of the hospital staff. He thinks this would give a higher standard for qualified roentgenologists.—*Audrey G. Morgan.*

STEBBING, G. F. Radiotherapeutic education of the future. *Brit. J. Radiol.*, Oct., 1942, 15, 294-296.

The Faculty of Radiologists now insists on the candidate for a Fellowship examination spending a year in a hospital appointment to acquire a knowledge of medicine, surgery and pathology. To get an adequate knowledge of the specialties he must work as a member of a team which should include a physician, surgeon, radiodiagnostician, laryngologist, gynecologist, physicist and pathologist. Each member of the team learns from the others. All of them should see the patient and have a first-hand knowledge of the disease.

After qualification he should spend two years doing house appointments at a teaching hospital. During this time he should learn all he can about clinical medicine and pathology and should attend as many postmortems as possible. After this he should spend a further period as a surgical registrar at a teaching hospital or as resident surgical officer in a hospital. He must be able to work equally well with roentgen rays and radium and in the latter work he must be capable of doing minor surgery and doing it well.

After this training in medicine and surgery he should spend a year in taking a course for the diploma in radiology. Radiotherapists and radiodiagnosticians should have separate training as these are quite different fields. After he gets his diploma in radiology he should get a post as assistant in a radiotherapeutic clinic where he can continue to learn radiotherapy and he should have some time to do research work as there is so much research to be done in this field.

This is a long and expensive course and there should be posts in which money can be earned and the developing radiation therapist given the status and responsibilities of other senior members of the staff.

Undergraduates in medicine should not be taught any radiation therapy for in this field as in many others a little knowledge is a dangerous thing. This teaching should be entirely post-graduate. General practitioners of medicine should be taught only the kind of cases that should be sent to the radiotherapeutic center.

There are few radiotherapists now being trained in England and the author suggests that the Director of the Emergency Medical Service in the Ministry of Health should encourage some of the younger surgeons to turn to radiotherapy.—*Audrey G. Morgan.*

TROSTLER, I. S. Employer is liable in common law for physician's fees for services rendered injured employe. *Radiology*, Feb., 1943, 40, 191-192.

Industrial commissions in several states have attempted to fix the amount of compensation to be paid physicians or surgeons for treating injured employes. But the Illinois Appellate and Supreme Courts have decided in several cases appealed from lower courts that the industrial commission has no authority or right as between the physician and his patient. The workmen's compensation laws make the employers and employes parties to a contract but the physician is not a party to this contract and has the same right to fix his fees as in other cases. Other states have made similar decisions and the higher courts of no state have upheld the industrial commissions in the matter. Cases are cited in which the decisions and the reasons for them are given at length.—*Audrey G. Morgan.*

McGRIGOR, D. B. Radiographic stereoscopy. *Brit. J. Radiol.*, Oct., 1942, 15, 273-281.

Stereoscopic roentgenography is of great advantage in the examination of regions such as the thorax, pelvis and skull where confusing superimposed shadows are placed in their separate planes in the stereoscopic image. But the correct technique for viewing stereograms is not very well understood and errors due to this fact has probably led to neglect of a very valuable method. The routine of making the stereograms is briefly described. The stereograms must be viewed both at the same time in such a way that the left eye sees only the one taken from the left tube shift and the right eye only the one taken from the right tube shift. A detailed description is given of the method of setting up the stereograms correctly. If the films are not placed upside down, sideways, or in such a way that the anatomical relations are incongruent, there are only four possible placements and only one of these gives a really correct stereoscopic view. The correct and incorrect combinations are shown by diagrams and ster-

eograms and their probable stereoscopic images by composite photographs.—*Audrey G. Morgan*.

KERLEY, PETER. Technique in mass miniature radiography. *Brit. J. Radiol.*, Dec., 1942, 15, 346-347.

The miniature roentgenogram does not compare in detail with the full-size one and therefore this method is used only for sifting cases of comparatively gross disease. The 5×4 inch film used in the United States does not show any greater detail than the miniature 35 mm. one and therefore the latter is to be preferred on account of cheapness and speed.

On a single posteroanterior view about 0.2 per cent of early tuberculous lesions are overlooked on account of their small size. With both anteroposterior and posteroanterior views they are much more apt to be projected free of rib shadows and detected. A survey with 35 mm. films has shown that with the two views diagnostic accuracy is about the same as that with full-size films. The disadvantage of taking two views is that fewer cases can be examined per hour and there is more wear and tear on the apparatus. A well trained team could probably take two views of 100 cases per hour. This is of no consequence compared with the great advantages of being able to detect early tuberculous lesions on the miniature roentgenogram.—*Audrey G. Morgan*.

BOURKE, V. V. A method for the localization of foreign bodies and a new instrument to carry out this method. *Radiology*, Jan., 1943, 40, 56-61.

A new and more accurate method of localizing foreign bodies is described which is based on the principle of parallax, that is, that shadows of foreign bodies at an equal distance from the roentgen tube move equal distances on the fluoroscopic screen when the tube is shifted.

There are two pieces of apparatus for carrying out the method. The first is a fluoroscopic screen which moves the length of the table and parallel to it. It also moves at right angles to the table and can be raised or lowered any desired distance. The tube beneath the screen and table except when released follows all lateral motions of the screen so that the vertical ray is always centered on the center point of the screen. The second piece of apparatus is a set of calipers, the tips of which can be raised or

lowered and a line connecting the tips will always be parallel to the plane of the fluoroscopic screen and table. When the arms are set at zero the tips will be together and in the vertical ray and their shadows will coincide with the center point on the screen. The screen and calipers are adjusted until the tips of the calipers make two indelible marks on the member containing the foreign body. A straight line drawn between these two points will pass through the foreign body while the distance of each mark from the foreign body is known from the readings on the calipers.

There is also an instrument to be used by the surgeon for the interpretation of the roentgen-ray markings and the localization of the foreign body. Any surgeon can adjust it in two minutes.

All the parts of the apparatus are illustrated and their application described in detail. The method is simple and requires no figuring or trigonometry. The measurements are mechanical, being read directly from the scale. The method is rapid, accurate and simple.—*Audrey G. Morgan*.

SCHWARZSCHILD, MYRON M. A multiple cassette changer for angiocardiology; device for rapid serial radiography. *Radiology*, Jan., 1943, 40, 72-74.

In angiocardiology a large amount of concentrated dye is rapidly injected into the brachial vein. Roentgenograms of the thorax taken immediately afterward show the course of the contrast medium through the heart and lungs. At present satisfactory results can be obtained only by direct roentgenography, using a 10×12 inch film. In order to obtain roentgenograms showing even one stage of the process a number of exposures, at least six, must be made in a short time.

The author describes and illustrates an improved apparatus for accomplishing this. It consists essentially of three compartments arranged in a straight line—the magazine compartment into which the cassettes are loaded, the exposure compartment in which each film is exposed and the receiver compartment in which they accumulate. The cassettes are stacked in the magazine compartment in front of a pressure block. The patient is positioned and the controls adjusted. The thrust bar is pushed in, pushing a cassette into position in front of the opening. The contrast substance is then injected. On withdrawal of the thrust bar

a pivoted mercrold switch closes the circuit, operating the roentgen ray timer and making an exposure. On the next inward thrust of the bar another cassette is pushed into position and this pushes the previous one into the receiver compartment. A simple timer has been incorporated into the device, so that each film carries a record of the time of its exposure.—*Audrey G. Morgan.*

BELL, A. L. L. X-ray therapy in fluoroscopy. *Radiology*, Feb., 1943, 40, 139-144.

It has been shown that relatively small doses of roentgen rays produce changes in the chromosomes that may affect the offspring and that the effect may be cumulative, not only during the life of the individual but during successive generations.

Now that fluoroscopes are produced at a price that makes them available to all, many physicians are doing their own roentgen examinations. In one eastern city it was found that practically one practicing physician out of four had a fluoroscope. Many of these fluoroscopes are provided with timers in an attempt to reduce the danger but if the whole of the dose is delivered over the pelvis or the lower abdomen the amount striking the gonads is much greater than if the upper part of the body is irradiated.

In order to determine the amount of radiation to which the patient is subjected in routine examinations, the author made measurements with a fluoroscope equipped with an ionization chamber and connected with a Braestrup irradiator. Tables are given showing the results which indicate that dangerous doses are often given, especially by untrained personnel or practicing physicians other than roentgenologists. The physician as well as the patient is exposed to danger unless he wears a lead-impregnated apron and gloves.

Fluoroscopic examinations should not be done promiscuously nor should the ovaries or testicles of patient or examiner be exposed unnecessarily.—*Audrey G. Morgan.*

SPEERT, HAROLD. Swallowing and gastrointes-

tinal activity in the fetal monkey. *Am. J. Obst. & Gynec.*, Jan., 1943, 45, 69-82.

Swallowing and gastrointestinal activity have been demonstrated in the fetal monkey by means of serial roentgenograms following the injection of radiopaque substances (usually thorotrast). The injection was made into the amniotic sac at various stages of gestation between 99 and 155 days. The following findings were noted: (1) The rate of swallowing of amniotic fluid increases and the emptying time of the fetal stomach decreases as pregnancy progresses. (2) No evidence exists that there is, normally, defecation in utero. (3) Water is absorbed by the fetal intestine thereby producing a concentration of the intestinal contents. (4) Rebreathing by the maternal animal has no demonstrable effect on the rate of propagation of the intestinal contents of the fetus.—*Mary Frances Vastine.*

JESSER, JOSEPH H., and DE TAKATS, GÉZA. Visualization of the pulmonary artery during its embolic obstruction. *Arch. Surg.*, June, 1941, 42, 1034-1041.

Contrast visualizations of right heart and pulmonary arteries in dogs, before and after production of massive pulmonary embolism, plus effects of several drugs on the appearance of these structures, are presented. On the basis of these observations, other experimental evidence and experience in emergency treatment of pulmonary embolism clinically the following conclusions are drawn:

(1) Epinephrine is contraindicated in pulmonary embolism because of its tendency to increase the pulmonary hypertension and accelerate failure of the right heart (neosynephrin and digitalis may work similar harm).

(2) Papaverine produces increased pulmonary vascularity and has a bronchodilator effect.

(3) Emergency treatment of pulmonary embolism should consist of administration of oxygen and intravenous injection of atropine and papaverine.—*H. G. Moehring.*









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*President of the American Roentgen Ray Society 1944-1945*

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## CONGENITAL ABSENCE OF THE LUNG (AGENESIS) AND OTHER ANOMALIES OF THE TRACHEOBRONCHIAL TREE

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SUCH developmental abnormalities as agenesis of an entire lung have been encountered so rarely that only about 50 cases have been recorded in the medical literature. Van Loon and Diamond,<sup>18</sup> from Jackson's Bronchoscopic Clinic in Philadelphia, in 1941 reported what was apparently the third case of agenesis of the lung diagnosed before death, and stated that until that time there were on record only 40 genuine cases of this congenital anomaly. In 1941, Geissler<sup>6</sup> described a postmortem examination of another similar case, and in June, 1942, Castellanos and Pereiras<sup>3</sup> from Cuba reported 3 additional cases, together with a review of the literature.

At The Children's Hospital in Boston during the past six years we have encountered 5 cases of agenesis of the lung, all 5 of which have been diagnosed during life by bronchoscopic examination followed by lipiodol roentgenograms of the tracheobronchial tree. Of these 5 cases, 4 are still living apparently normal lives, while autopsy confirmed the clinical diagnosis of the fifth.

Munchmeyer<sup>14</sup> in 1885 is credited with

having made the first diagnosis of unilateral pulmonary agenesis on the basis of a physical examination, subsequently verified by autopsy. This condition was found in a two year old boy who had died of pneumonia shortly after the clinical diagnosis of agenesis had been made. In 1893, Schmit<sup>15</sup> described a case of bilateral agenesis of the lungs in a fetus of eight months' gestation, whose trachea had not as yet separated from the esophageal wall, but whose larynx was well developed. There were no pleural membranes, and no vestiges of pulmonary veins. The pulmonary arteries connected with the descending aorta.

It was not until 1928 that Gilkey<sup>7</sup> reported the second case of agenesis of the lung diagnosed during life. The patient of Van Loon and Diamond<sup>18</sup> was apparently the third case clinically diagnosed. For this reason, 5 cases recognized during life at one clinic, together with their respective bronchograms, should prove of interest. Furthermore, the report of these cases should stimulate more general investigation of obscure lung conditions by recommended methods of bronchoscopy and lipiodol in-

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jection. Hurwitz and Stevens<sup>10</sup> in 1937 published a complete tabulation of the 34 cases recorded until that time. According to this report and the literature in general, the sex ratio favors the males in a proportion of about three to two. The anomaly has been found to occur somewhat more commonly on the left side than on the right, in a proportion of nearly two to one. In our series of 5 cases, there was agenesis of the left lung in 3 patients and of the right lung in 2 patients. Of these, however, 3 were females and 2 were males. It is impossible to offer any estimate as to the general incidence of this condition, inasmuch as the total number of reported cases is so small, and the literature is composed almost entirely of individual case reports. Killingsworth and Hibbs<sup>11</sup> reported that of the 37 authentic cases in the literature until 1939, twenty-four had been found in children under twelve years of age. Of these, 3 were still-born, 5 were infants under one week, 13 were under six months of age, 2 under three years, 1 was eight years and 1 was twelve years of age. In 24 of the 37 cases, the left lung was involved. In those cases in which the sex was reported, there were 20 males and 13 females.

The cause of this condition is unknown, but various theories have been propounded in an attempt to offer some explanation for the developmental defect. Meckel and Fleischmann<sup>13</sup> have suggested a cause on a phylogenetic basis, and regard the condition as an atavistic reversion to a reptilian stage. Klebs<sup>12</sup> explains an agenesis of the right lung as the result of excessive tension on the amnion, produced as the embryo normally rotates to the left, thereby preventing proper development of the right lung. This, however, leaves no room for an explanation of the left-sided defect, and the left side is the one more commonly found to be aplastic. Eppinger's<sup>5</sup> theory deals with enlargement and displacement of the thymus gland, thereby causing undue pressure on the developing bronchopulmonary system. Gruenfeld and Gray<sup>8</sup> feel that the phylogenetic newness of the lung, plus the

enormous growth the lung must undergo before its functional form is achieved, has some bearing on the development of abnormalities. Tichomiroff<sup>17</sup> believed that hydrops fetalis or some early intrauterine infection might be the cause of the defect. One of the most plausible theories is that of Schwalbe,<sup>16</sup> who postulates that the condition is due to a developmental error of endogenous origin; that is, it is the result of an inherently faulty germ-plasm. According to Schwalbe, there is a primary defect in the pulmonary vascular, as well as in the respiratory system. The pulmonary vessels on the affected side are usually absent and a single pulmonary artery often supplies the hypertrophied lung. The aortic vessels may arise from a common trunk. This theory of a developmental error of endogenous origin seems most logical, inasmuch as other abnormalities of development are often associated in the same patient. It is surprising to note the great number of cases in the literature which have shown coincidental anomalies. These anomalies have included such local defects as a narrowed trachea, extra cartilaginous rings, supernumerary bronchi of the normal lung, absence of the pleura on the affected side, tracheo-esophageal fistula, esophageal stenosis and synostosis of various ribs. In addition, other more distant congenital abnormalities have been reported; such as, absent diaphragm on the affected side; atresia of the anus; hypoplasia of the face; absence of one ovary and tube; dermoid of the eye; agenesis of the spleen, kidney and ureter; accessory or hypertrophied thymus; exencephaly; absent vagus nerve and various bone and cardiovascular anomalies. Each of our 5 cases had some other anomaly, such as a harelip and cleft palate, an absent wrist and hand on the same side as the aplastic lung, an anomaly of the external ear and other minor congenital defects.

To understand this condition more clearly, it is important to look briefly at the embryology of the bronchopulmonary system. According to Arey,<sup>1</sup> "A groove-like evagination occurs on the ventral surface of

the esophagus in the 3 mm. human embryo. From the enlarged posterior ends of the groove, two small lung buds grow out. Later in the development, the predestined anlage of the trachea and esophagus become separated by a constriction, interrupted at the cephalic end by the larynx which can be seen in the embryo at the end of the fifth week. Muscle fibers and cartilaginous rings differentiate from the surrounding mesenchyme by the end of the seventh week. In a later development of the lung buds, hollow evaginations grow out into the envelope of connective tissue, enlarge rapidly and branch to produce the tree-like tubular system. On the fine terminal tubules arise small out-growths which constitute the alveoli." Therefore, complete absence of the lung, with no lung bud or main stem bronchus whatever, indicates a developmental defect which has occurred very early in fetal life. Those cases which occur in Groups II or III, to be described in the next paragraph, with either a rudimentary bronchus or a fairly well developed bronchus with no lung tissue, are due to failure of development occurring at a somewhat later embryonic stage.

Schneider<sup>16</sup> has divided the cases of pulmonary agenesis into three distinct anatomic classifications, depending on the age at which the developmental defect occurred. I. True aplasia—cases in which there is no trace of a lung, bronchus or vascular supply to the affected side. II. Cases in which there is a tiny out-pocketing of the trachea; that is, a primordial bronchial bud, but no lung tissue. III. Extreme hypoplasia—cases in which the bronchus is fully developed, but reduced in size and ending in a fleshy structure without lobes which lies in the mediastinum. The great majority of cases reported fall in the first category; namely, a true aplasia. However, only 2 of our 5 cases fell in this group, while the other 3 showed (on the lipiodol bronchograms) rudimentary bronchial buds, but no evidence of lung tissue. The third group of cases, that is those of hypoplasia of the lung but with a fairly well formed bronchus, is

apparently quite small and, up to 1934, only 5 such cases had been reported (Dyson<sup>4</sup>).

Symptoms produced by agenesis of the lung may be very variable, or may be entirely lacking. In fact, some of our cases were suspected only during physical examinations in otherwise essentially normal children. One may possibly encounter in such cases a diminished respiratory excursion on the affected side; a slight flattening of the thorax with possible scoliosis (although usually the chest is symmetrical); dullness or flatness to percussion, unless the compensatory emphysema of the other lung confuses the picture; absent breath sounds; or bronchial breathing. In practically every case, the potentially vacant space in the chest is filled with displaced heart, thymus and other mediastinal contents; and, on occasions, there may be clinical evidence of fluid in the chest. Dyspnea, stridor and even cyanosis have been reported.

At postmortem examination, the pleura may be defective or completely absent. The affected side of the chest cavity may be filled with fluid, but in most cases only with the displaced mediastinal structures. If the bronchus is present, it is usually short and rudimentary. If no bronchus is present, the trachea and single bronchus may be perfectly uniform in diameter throughout, with no evidence of division and no narrowing. Two of our cases showed a "trachea" or "bronchus" which connected the larynx with the hilum of the normal lung, and which did not vary at all in diameter. Here there was no evidence of a bronchial bud. The trachea, however, may be narrowed and the cartilaginous rings may be increased in number. The pulmonary vessels are usually absent, and a single pulmonary artery often supplies the hypertrophied lung. The aortic vessels may arise from a common trunk and the venous return of the normal lung may reach the left auricle by way of one or more vessels or empty directly into the azygos vein. The functioning lung is usually hypertrophied and emphysematous and may show abnor-

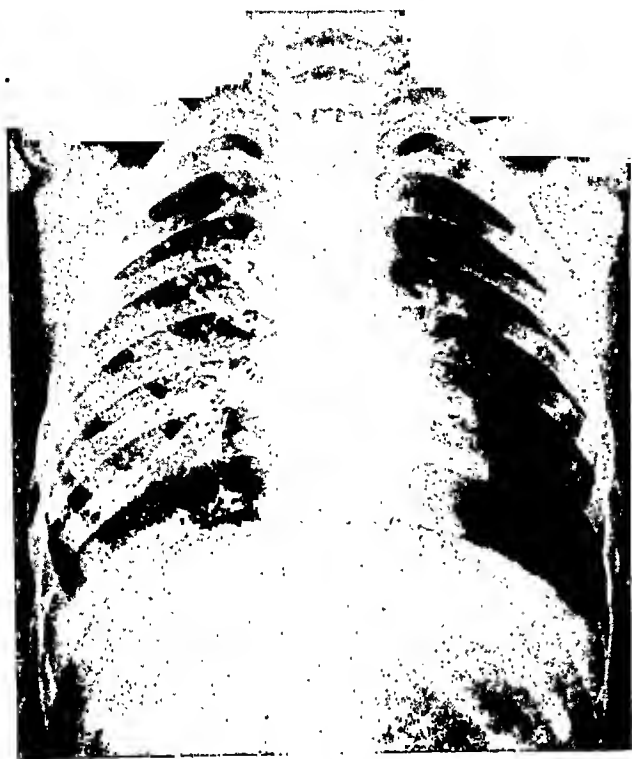


FIG. 1. (R. R.) The right upper lobe bronchus emerges from the trachea above the bifurcation. There is marked irregular stenosis of the trachea between the bifurcation and the emergence of the upper lobe bronchus.

mal lobulation. Possibly there may also be pneumonia and in one case bronchiectasis was reported. Very often, cases are erroneously diagnosed as pneumonia, massive atelectasis, foreign body in the bronchus, hydrothorax, diaphragmatic hernia or diaphragmatic paralysis. However, from the roentgenograms alone the condition may often be suspected. There is generally a dense, homogeneous shadow on the affected side, with displacement of the heart and mediastinum to that side and with elevation of the diaphragm and narrowing of the intercostal spaces. There may be some abnormality of the thoracic cage or even some scoliosis.

As Hurwitz and Stevens<sup>10</sup> suggested in 1937, bronchoscopy is the only rational and final method for accurate clinical diagnosis. These authors claim priority for advocating this procedure in such cases. Lipiodol injection at the time of bronchoscopy should solve the problem. However, the seven weeks old baby girl reported by Hurwitz

and Stevens died two days after its second bronchoscopy and no diagnosis was made until the time of postmortem examination. In this case, no lipiodol was injected since the baby was in poor general condition. The practice of thoracic paracentesis as a diagnostic measure is mentioned only to be condemned, although in the past it has been too frequently employed. In the hands of one experienced in the use of the bronchoscope in infants and children and in the technique of lipiodol injection, the procedure should prove neither difficult for the operator nor dangerous to the patient.

It is quite obvious that the prognosis in congenital absence of a lung should always be guarded. In the first place, there may be other unknown congenital anomalies, which may of themselves prove serious. In addition, any otherwise insignificant involvement of the only existing lung, whether it be from infection, foreign body or trauma, may cause sudden fatality. However, Killingsworth and Hibbs<sup>11</sup> report that 11 cases in the literature lived beyond nineteen years of age, while 3 were fifty-eight, sixty-



FIG. 2. (R. R.) Slightly oblique view to show the marked stenosis of the trachea.

five and seventy-two years of age respectively at the time of death. All of these patients died of causes unrelated to the pulmonary agenesis. Heerup<sup>9</sup> in 1927 reported the case of a seventy-two year old woman who died of cerebral hemorrhage before the absence of the lung was discovered. Therefore, the condition may be compatible with longevity.

As lipiodol roentgenograms become more universally employed in the diagnostic study of unusual lung conditions, there will obviously be an increase in the number of reported cases, not only of agenesis, but also of various other bronchopulmonary anomalies. In patients who have had pneumonia recur several times in the same lobe, a congenital malformation of that bronchus must be suspected. One such patient (R. R.) (Fig. 1 and 2) showed a narrow angulated bronchus to the right upper lobe arising above the tracheal bifurcation. An area of localized atelectasis or emphysema also demands investigation by bronchoscopic methods, not only for the relief of the local defect, but also for the determination of its cause. One of our patients (G. B.) (Fig. 3 and 4) was studied because of persistent



FIG. 3. (G. B.) Atelectasis of the right middle and lower lobes, with a marked shift of the heart and mediastinum to the right, and elevation of the right dome of the diaphragm.

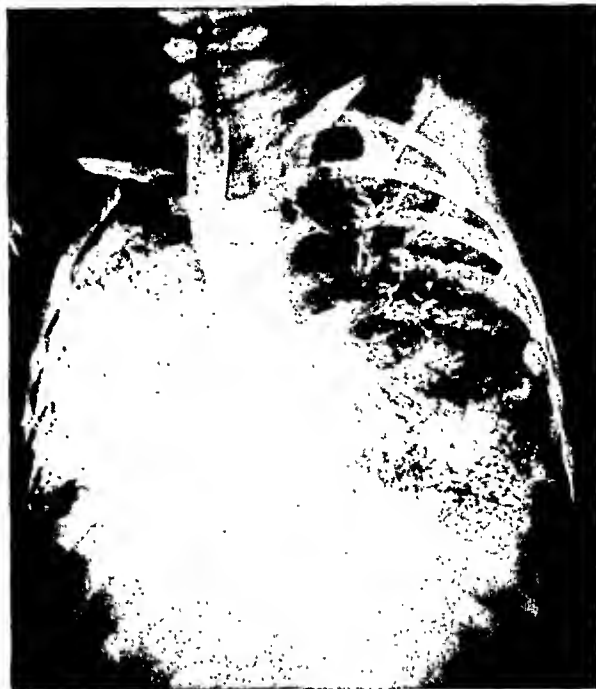


FIG. 4. (G. B.) Bronchograms show a single right main bronchus, with no evidence of a bronchus to either the middle or lower lobes on the right side.

atelectasis of the right middle and lower lobes. Only a single bronchus was found on the right side, and it communicated only with the upper lobe. Very little attention has hitherto been given such conditions, except in the case of foreign bodies. Two of the cases of tracheobronchial tree anomaly (P. G. and J. C.) showed findings consistent with pulmonary emphysema as a result of intrinsic bronchial obstruction due to a foreign body. The roentgenograms were classical—showing increased aeration of the affected lung, displacement of the heart and mediastinum to the opposite side, widening of the interspaces and depression of the diaphragm. In 1 of the patients (P. G.) (Fig. 5), who was studied in 1931, no bronchoscopy was performed, but postmortem examination disclosed merely an absence of the cartilaginous rings of the main bronchus. During inspiration the bronchus probably dilated and air entered the lungs; but on expiration the bronchial walls collapsed, producing a "ball-valve" action which entrapped the inspired air. The total effect on the lung was that of obstructive emphy-



FIG. 5. (P. G.) Obstructive emphysema of the left lung, associated with absent cartilaginous rings of the left main bronchus.

sema, exactly similar to that caused by a bronchial foreign body. Another case (J. C.) (Fig. 6) showed exactly the same physical and roentgen findings, while bronchoscopic examination revealed complete collapse of the bronchial walls during expiration. The bronchoscope could easily be passed down the bronchus, and no constriction was noted. As it was withdrawn, the walls completely collapsed below it, coincidental with a "flapping" noise noted during each expiratory phase. Very recently, postmortem examination was performed on a child who died suddenly during a general anesthetic for an orthopedic operation. At autopsy, among other congenital anomalies, the orifices of some of the bronchi were noted to be in a collapsed state but were very easily opened by slight traction on the bronchial and tracheal walls. Microscopic studies showed a deficiency of the cartilaginous rings in the locality of the collapsible bronchi. Unfortunately, we did not have an opportunity to perform a bronchoscopic examination of this child during life.

In 1932, Bremer<sup>2</sup> reported the addition to the Harvard Embryological Collection of a 16.5 millimeter human embryo with a large bronchus arising from the right side of the trachea a short distance above the bifurca-

tion and extending caudally. He states that of the 80 human embryos in the Collection ranging from 5 to 45 mm., 3 others showed a tracheal bronchus. Two of them had two tracheal buds. Five of the six tracheal buds were on the right side and only one on the left side. Apparently a tracheal bronchus is a normal phenomenon in certain species, such as the sheep and the pig. Bremer is impressed with the 5 per cent incidence of such findings in the human embryo collection and its relative rarity in adults. He therefore feels that many tracheal buds probably disappear during the process of development, possibly the result of simple absorption. This may account for certain irregularities of the tracheal cartilages seen in adult life, as well as weak areas in the musculature, tracheal diverticula or other anomalies. The anomalous tracheal buds may develop into accessory bronchi to normal apical lobes or into bronchi to accessory apical lobes or even into bronchi to a third lung in the mediastinum. The patient (R. R.) (Fig. 1 and 2) who had had pneu-

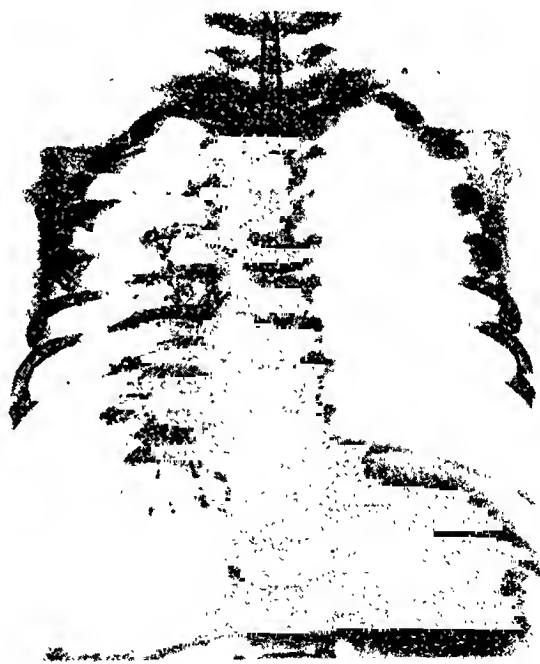


FIG. 6. (J. C.) Bronchograms show considerable narrowing of the entire tracheobronchial tree, with obstructive emphysema of the left lung, associated with absence of the cartilaginous rings of the left main bronchus.



monia recur in the right upper lobe on several occasions, showed an upper lobe bronchus arising from the right side of the trachea, in the same manner as the embryo demonstrated.

#### CASE REPORTS

**CASE I.** E.M. (C.H.No. 192533) This patient, female, aged two years and nine months, was admitted to the Medical Service on October 26, 1937, with a history of cough since the age of two months. Her family history was significant only in that an aunt had died at the age of twenty of congenital heart disease. The baby was delivered three weeks prematurely and weighed only  $4\frac{1}{2}$  pounds. The only abnormalities noted at birth were an absent left hand and a left facial weakness. The facial palsy subsided spontaneously. Several weeks after birth, the patient developed an unproductive cough associated with noisy respirations, and a poor gain in weight. Examination at the time of admission showed a child whose left chest measured 8.5 cm. in circumference and the right 9 cm. There was no obvious flattening. On percussion, the chest was dull to flat throughout the left side and fremitus and breath sounds were absent. The heart was displaced to the left. The left hand was absent. The roentgenograms (Fig. 7) showed no abnormality of the bony thorax except that the left hemithorax was considerably smaller than the right. The heart and mediastinal structures showed a marked shift to the left. The right lung was

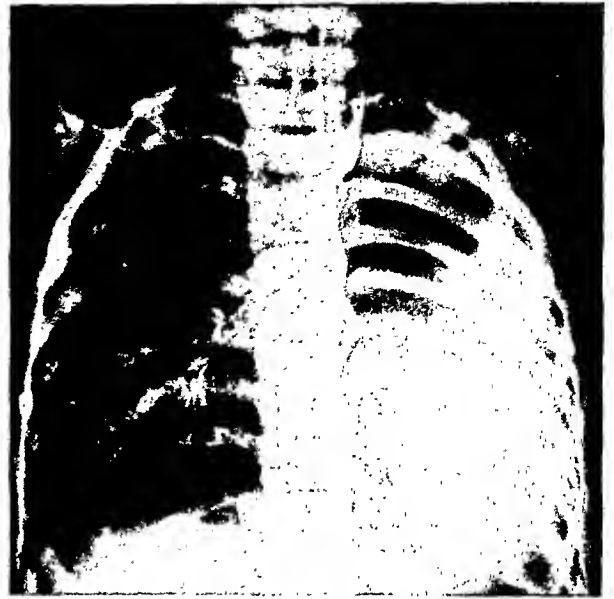


FIG. 8. Case 1. Agenesis of left lung, showing small bronchial rudiment.

emphysematous and extended far beyond the midline to the left. The remaining portion of the left hemithorax was opaque. On October 30, 1937, bronchoscopy was performed under avertin-ether anesthesia and lipiodol injected into the tracheobronchial tree. There appeared to be an abrupt ending of the left main bronchus about 1 cm. beyond the bifurcation. Bronchograms (Fig. 8) showed a moderate shift of the trachea to the left and no definite abnormality of the right bronchial tree. The left main bronchus was about 1 cm. in length, quite narrow and with a blunted and abrupt termination. This patient has continued to live an essentially normal life. In April, 1941, mastoidectomy was uneventfully performed under general anesthesia. In July, 1942, her tonsils and adenoids were removed under general anesthesia without event. At the present time, she is eight and one-half years of age and is still living a normal life without restriction of activity.



FIG. 7. Case 1. Agenesis of the left lung.

**CASE II.** B. W. (C. H. No. 229558) This baby girl, aged four months, was admitted to the Infants' Hospital on February 22, 1939, because of respiratory embarrassment since birth. The family history was essentially negative. The patient's birth was uneventful. At two weeks of age, it was first noted that her respirations were noisy and rapid. When disturbed there was cyanosis. Examination at the time of admission to the hospital showed an infant with a harsh inspiratory crow and definite retraction of the

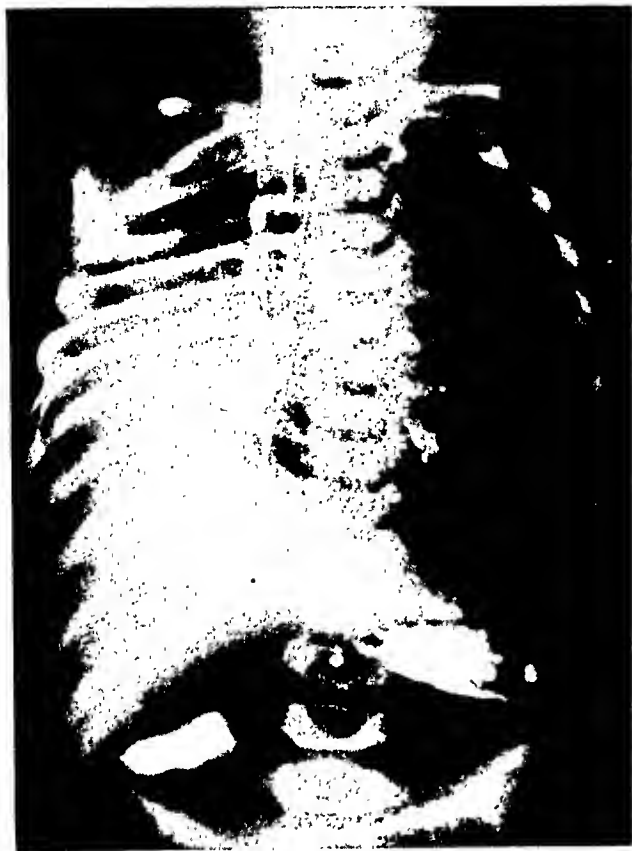


FIG. 9. Case II. Agenesia of right lung, showing small bronchial bud.

interspaces on the left side. The right side of the chest moved very little with respirations. The trachea was deviated to the right side. There was dullness and flatness over the entire right chest, while the left chest was hyperresonant. The breath sounds on the left were loud and on the right were diminished to absent. Congenital atelectasis or agenesia of the right lung was suspected, so bronchoscopy was performed on February 28, 1939, under avertin-ether anesthesia. The trachea was found to be displaced to the right and no right bronchus was visible. Lipiodol bronchograms (Fig. 9 and 10) showed a marked shift of the trachea to the right and no definite abnormality of the left bronchial tree. There was a small bud-like structure which filled with lipiodol and apparently represented an abortive right main bronchus. The patient did quite well for two days after bronchoscopy. At that time, she began to develop increasing dyspnea with some cyanosis and showed signs of pneumonia. On the sixth postoperative day, with a temperature rising to  $106^{\circ}$  F. and with increasing signs of infection, the patient died. Autopsy showed an absent right lung and bronchus, a patent ductus arteriosus, hypo-

plasia of the spleen, kidney and liver and an accessory spleen. (The lung is reproduced in Figure 11.) There was a rather marked interstitial pneumonia. At the usual point of origin of the right main bronchus there was a small bud-like structure which corresponded to the right lung. There was no pulmonary artery and no pulmonary vein.

CASE III. J. F. (C. H. No. 235096) This six month old baby boy was admitted to the Surgical Service on November 8, 1939, because of a congenital deformity of his left external ear. The family history was entirely negative. The birth history was also normal. At birth, the malformed left auricle was noted as the only abnormality. At the time of admission, examination showed a deformity of the left auricle. The patient was noted on physical examination to have a somewhat diminished chest expansion on the left side, where there was definite dullness and flatness throughout, with markedly diminished to absent breath sounds. Respirations were slightly rapid, but not difficult. The heart and trachea were displaced to the left side. Roentgenograms (Fig. 12) showed no ab-



FIG. 10. Case II. Agenesia of right lung, oblique view.

normality of the thorax except that the left hemithorax was considerably smaller than the right, with a marked shift of the heart and mediastinum to the left, so that the heart was entirely within the left hemithorax. The right lung was emphysematous and extended to the left beyond the midline. The left hemithorax was opaque. It was felt advisable to perform



FIG. 12. Case III. Agenesis of left lung.

mal. The patient was discharged home in good condition ten days after admission. Since that time, he has lived a perfectly normal life. He was last heard from a few months ago and was planning to come back to the hospital for a plastic operation to his left external ear. He apparently has never had symptoms related to the absent lung.

CASE IV. J. R. (C. H. No. 263317) This baby girl, aged four months, came into the Out-Patient Department of the hospital on June 25, 1942, with a story that her respirations had al-

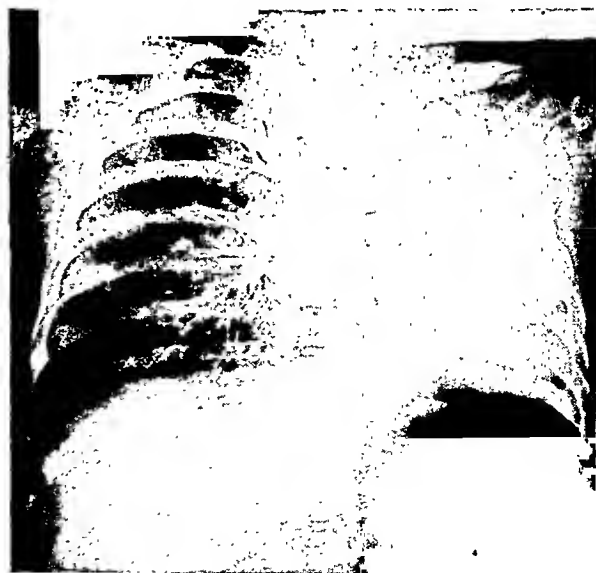


FIG. 13. Case III. Agenesis of left lung, showing marked hypogenesis of left bronchial tree.



FIG. 11. Case II. Pathological specimen showing agenesis of right lung.

bronchoscopy and inject lipiodol. On the second hospital day, this procedure was carried out under ether anesthesia. Bronchograms (Fig. 13) showed that the right bronchial tree was apparently normal. The left main bronchus was about 3 cm. in length and formed only a minimal angle with the trachea at the bifurcation. The bronchus was narrowed and quite irregular and had two minute prolongations, apparently representing the first subdivision. Electrocardiogram showed no axis deviation, but unusually wide deflection in leads 1 and 3. Barium studies of the esophagus and stomach were nor-



FIG. 14. Case IV. Agenesis of right lung.

ways been rapid, but never labored, and she had had no cyanosis. Two weeks before admission to the Out-Patient Department, a roentgenogram of her chest had been taken and a congenital anomaly suspected. The family history was negative. Birth history was also negative. Examination showed diminished expansion of the chest on the right side, with a scoliosis in the thoracic region with a convexity to the left. The



FIG. 15. Case IV. Agenesis of right lung, showing marked distortion of the tracheobronchial tree, with absence of the right main bronchus.

right side of the chest was flat to percussion and no cardiac dullness was found on the left side. The heart and trachea were displaced to the right side. The breath sounds on the right were extremely distant. Roentgenograms (Fig. 14) showed a fairly marked left dorsal scoliosis with multiple congenital anomalies of the high dorsal vertebrae, including several hemivertebrae and a spina bifida. The ribs on the right



FIG. 16. Case IV. Agenesis of right lung, oblique view.

also showed multiple congenital abnormalities, with fusion of the third to sixth ribs on the right. There was a marked shift of the heart and mediastinum to the right and the right hemithorax was opaque. The left lung showed considerable emphysema. The patient was admitted to the hospital and on July 3, 1943, bronchoscopy was performed under ether anesthesia. The bronchoscope was passed to the region where the bifurcation ordinarily should have been, but met complete obstruction. It was impossible to pass the bronchoscope beyond this region, either to one side or to the other. Lipiodol was injected and the bronchograms (Fig. 15 and 16) showed that the entire trachea was somewhat narrowed and showed a

rather marked shift to the right and marked convexity to the right and posteriorly. The trachea continued directly into the left main bronchus, but showed no definite abnormality of the main portions or of its subdivisions. There was no evidence of a right main bronchus. The patient was discharged home five days after bronchoscopy in good condition and has lived an uneventful life since that time. She was last seen a few months ago, at which time she had no complaints and was in excellent physical condition.

CASE V. D. S. (C. H. No. 232923) This three weeks old baby boy was first admitted to the hospital on June 2, 1939, at which time a hare-



FIG. 17. Case v. Agenesis of left lung.

lip was repaired under ether anesthesia. His family history and birth history were negative. After the harelip operation, he had recurring cyanosis for the first two postoperative days. Thirteen days later he was discharged home in good condition. No abnormality of his lungs was mentioned at this admission. He remained perfectly well until he was re-admitted, on July 6, 1942, at the age of three years and two months, for repair of the cleft palate. On the routine admission examination at that time, his chest presented definite abnormalities. The thoracic cage was symmetrical, but the respiratory excursion on the left side seemed to be somewhat diminished. There was marked flatness of the left side of the chest, with marked displacement of the heart to the left. The breath sounds were very distant on the left,

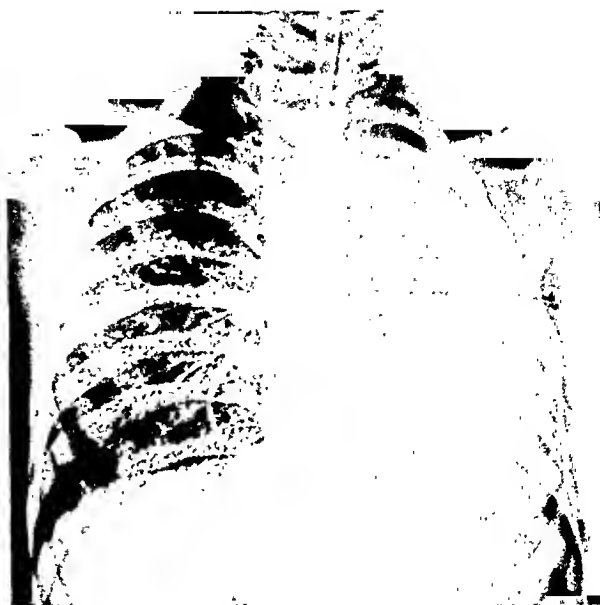


FIG. 18. Case v. Agenesis of left lung, showing absence of left main bronchus.

but heard at the apex and along the left border of the sternum. Roentgenograms (Fig. 17) showed no definite abnormality of the thorax except that the left hemithorax was considerably smaller than the right. There was a marked shift of the heart and mediastinum to the left

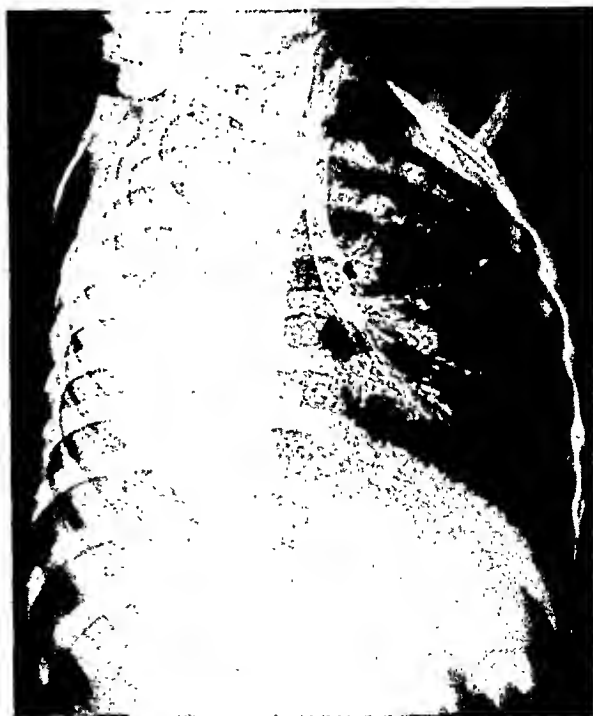


FIG. 19. Case v. Agenesis of left lung. Oblique view.

and the left hemithorax was opaque. The right lung showed considerable emphysema and extended beyond the midline to the left. It was felt that bronchoscopy should be carried out. This was accordingly done on July 8, 1942. No bifurcation was seen, but the bronchoscope could be passed for a relatively long distance through what appeared to be an abnormally long trachea. The trachea, however, was somewhat narrowed. Lipiodol bronchograms (Fig. 18 and 19) showed no definite abnormality of the right bronchial tree and no evidence of a left bronchus. Two days after this procedure, his tonsils and adenoids were uneventfully removed under ether anesthesia. In September, 1942, he returned for a repair of his cleft palate, which was also done under general anesthesia. He was last seen during a check-up in the Out-Patient Department this year (1943) in excellent condition and apparently living a normal life.

These 5 cases of agenesis of the lung illustrate the fact that this deformity is not incompatible with a normal existence. Four out of these 5 patients are living perfectly normal lives and are not as yet handicapped by their defect. It is also interesting that all 5 cases showed additional congenital anomalies. In the first case, there was an absent hand. In the second case, there was a patent ductus arteriosus, accessory spleen with hypoplasia, and hypoplasia of the kidney and liver. In the third case, there was a congenital malformation of the external ear. In the fourth case, there were congenital anomalies of the vertebrae and ribs noted by the roentgenograms. In the fifth case, there was a harelip and a complete cleft palate. The cases in the literature also have showed very frequent associations of other congenital anomalies. For this reason, we feel that an inherent defect in the germ-plasm is probably responsible for this as well as the other associated congenital anomalies.

#### SUMMARY

1. Agenesis of the lung is a relatively uncommon congenital anomaly, and thus far only about fifty cases have been recorded. Of these, only about six have been diag-

nosed before postmortem examination.

2. From The Children's Hospital in Boston five cases of agenesis of the lung are reported, all of which have been diagnosed during life. Of these five patients, four are still living and well.

3. According to the literature, this anomaly occurs more commonly in males than females, and is noted more often on the left side than the right. In our cases three of the patients were females, and the absent lung was found on the left side in three cases.

4. The condition is probably the result of an inherent defect in the germ plasm, as there are often associated congenital anomalies. All of our five patients showed additional abnormalities of development.

5. The symptoms are so inconstant or lacking that roentgen studies plus bronchoscopy with lipiodol injection of the tracheobronchial tree are the recommended methods for diagnosis.

6. The prognosis should always be guarded, although the condition is compatible with longevity. Three of the patients reported in the literature lived well over fifty years. Of our five cases four are still living normal lives, and the oldest is over eight years of age.

7. In cases of persistent emphysema or atelectasis, or cases of supposed unresolved pneumonia, or recurrent pneumonia in the same lobe, congenital anomalies of the tracheobronchial tree must be considered.

8. Case histories of five patients with agenesis of the lung are presented, accompanied by their respective roentgenograms and bronchograms.

9. Bronchograms of five cases of tracheobronchial tree anomalies are also presented.

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# PULMONARY DISEASE ASSOCIATED WITH MEGA-ESOPHAGUS

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## INTRODUCTION

ALTHOUGH the condition commonly described as mega-esophagus or cardio-spasm has been carefully studied in numerous papers, little attention has been given to the occurrence of pulmonary lesions which may accompany this disorder.

Recently a small group of patients with mega-esophagus was observed at Grady Hospital which presented interesting pulmonary manifestations, such as lung abscess, chronic and acute aspiration pneumonitis, and bronchiectasis. It will be the purpose of this paper to emphasize the occurrence of these pulmonary lesions, the symptoms and signs of which may completely overshadow the features of the associated esophageal disease. The recognition of the association of these conditions is of clinical importance since the presence of mega-esophagus has frequently remained unrecognized for many years.

A review of the literature reveals that this subject has received surprisingly little attention. Vinson<sup>14</sup> reported the occurrence of a pulmonary abscess in a patient with mega-esophagus, which responded to conservative treatment. Sampson<sup>8</sup> discussed a similar case in which the presence of mega-esophagus was not discovered for many years. Aspiration pneumonitis as a complication of mega-esophagus was described by Cummins and Williams.<sup>3</sup> A similar observation was made by Baldwin<sup>1</sup> and recently by Warring and Rilance.<sup>15</sup> The simultaneous occurrence of bronchiectasis and mega-esophagus has been recorded by Schrire<sup>9</sup> and Reeke.<sup>7</sup>

The reports in which larger series of patients with mega-esophagus were investigated draw little attention to the occurrence of pulmonary manifestations. Sturtevant,<sup>10</sup> in a summarizing report and review of the

literature, referred to a case of Thomas and Jewett,<sup>11</sup> in which a patient with mega-esophagus developed lipoid pneumonia as the result of aspiration of milk and cream. Verbrycke,<sup>12</sup> in a study of 100 cases of "cardiospasm," does not mention chest complications. Vinson,<sup>13</sup> in a large series of 415 cases, stated that in 49 patients respiratory symptoms were present, usually "consisting of nocturnal cough, and dyspnea after meals, due to regurgitation or pressure from the dilated esophagus filled with food." There were no roentgenological findings or clinical signs of pulmonary disease described in this study.

During the last four years 15 cases of mega-esophagus have been observed in the Department of Roentgenology of Grady Hospital. In 5 of these cases pulmonary disease was demonstrated roentgenologically. Two other patients revealed repeated pleural effusions. Since one of these patients developed tuberculosis these two cases are not included in this study. This would indicate a rather high incidence. However, it is felt that no definite statistical conclusions should be drawn from such a small series.

In the following case reports various forms of pulmonary disease, associated with mega-esophagus, are illustrated.

## REPORT OF CASES

### CASE I. *Mega-esophagus and Pulmonary Abscess.*

J. S., a colored male, aged twenty-nine, was apparently well until the middle of September, 1942, when he became ill with cough, fever, and a chill. On a visit to the emergency clinic a chest roentgenogram was taken, which showed an abscess cavity with a horizontal fluid level in the right upper lobe (Fig. 1). The patient returned home and was treated by his private physician with sulfathiazole. He began to bring

up foul-smelling sputum which was occasionally blood stained and he remained in bed for one month. After this interval he showed some improvement. As soon as he returned to work the sputum became copious again and he complained of chest pain. Increasing weight loss, weakness, and daily fever made him seek admission to the hospital.

The physical examination revealed signs of consolidation over the right upper and posterior lung field. The laboratory findings showed a normal red blood cell count and moderate leukocytosis. The Kahn reaction was negative. Repeated sputum examinations revealed a few gram-positive diplococci; there were no acid-fast bacilli detected.

*Roentgenological Findings.* The first examination (October 9, 1942) showed an abscess cavity, measuring about 2 cm. in diameter, in the apical portion of the right upper lobe (Fig. 1). The cavity showed a horizontal fluid level and was surrounded by considerable parenchymal reaction. The mediastinal shadow on the right side protruded into the right lung field and formed an angle which pointed to the midline in the region of the right lung root. On account of the peculiar mediastinal shadow the esopha-

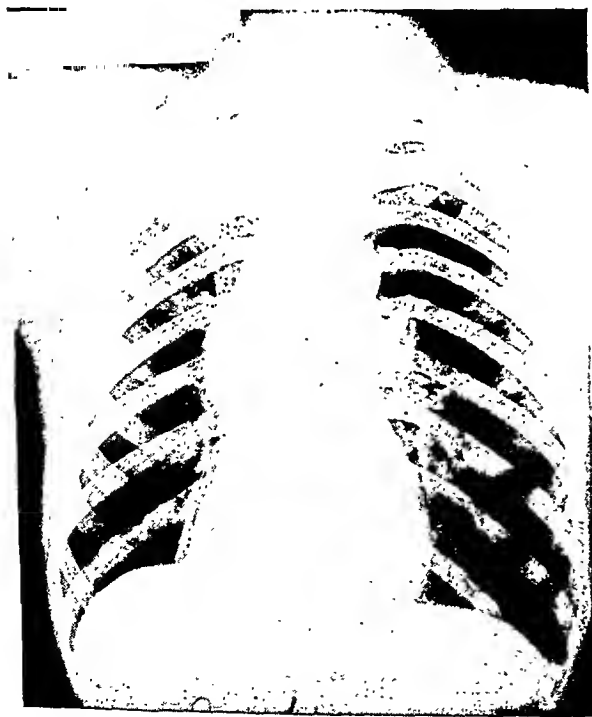


FIG. 1. Case 1. Pulmonary abscess in the right infra-clavicular lung field. Angular mediastinal shadow due to dilated esophagus.



FIG. 2. Case 1. Dilated esophagus after administration of barium.

gus was investigated upon his return to the hospital (January 7, 1943). It was found to be markedly dilated, displacing the trachea anteriorly (Fig. 2). The right lung root caused a characteristic pressure defect on the wall of the dilated esophagus. The fluid level was no longer visible in the abscess cavity, but the density in the right upper lobe was larger in size and had a somewhat honey-combed appearance. Subsequent examinations showed satisfactory decrease in the size of the parenchymal lesions.

An esophagoscopy examination revealed a markedly dilated esophagus, the lower segment of which was resting on the diaphragm. The cardia was found wide open.

After the diagnosis of mega-esophagus was established the symptoms of the patient were re-investigated. After repeated questioning he admitted that he had been having difficulty in swallowing for over ten years and that his esophagus had been previously dilated. He also stated that occasionally, after going to bed, he would regurgitate material which would choke him.

The patient left the hospital against medical advice.

*Comment.* A patient with mega-esopha-



FIG. 3. Case II. Mega-esophagus outlined with barium. Note widening of mediastinal shadow and bilateral aspiration pneumonitis.

gus developed a pulmonary abscess, the symptoms and signs of which dominated the clinical picture. The esophagus showed very marked dilatation and produced a somewhat peculiar angulated mediastinal shadow. The abscess was believed to be the result of aspiration of esophageal contents into the right upper lobe bronchus.

#### CASE II. *Mega-esophagus and Aspiration Pneumonitis.*

W. C. G., a colored female, aged thirty-seven, was admitted to Grady Hospital for surgical removal of a pelvic tumor. The history did not reveal any respiratory or digestive complaints. On physical examination the thyroid gland was bilaterally palpable and enlarged. The lungs were clear on auscultation. A large mass filled the lower abdomen and pelvis, extending upward to the umbilicus. The red blood cell count was 3,730,000 per cubic millimeter, the hemoglobin content 12 gm. per 100 cc., and the white blood cell count 7,750 per cubic millimeter. Under spinal anesthesia the uterus, both tubes, and the ovaries were removed. The pathological examination of the surgical specimen revealed leiomyomata of the uterus, simple cysts

of both ovaries, and a Brenner tumor of the right ovary.

After operation the patient developed intermittent fever. On the sixth postoperative day cough and coryza were noted. The cough was productive and the sputum consisted of fairly large amounts of yellowish material. The right chest was filled with coarse bubbling râles, a few fine râles were heard on the left side. The sputum showed numerous long-chained streptococci and no evidence of acid-fast organisms. The patient was treated with sulfathiazole and developed fever, thought to be caused by the drug. After chemotherapy was discontinued the patient improved and became symptomless.

Roentgenological examination of the chest (May 20, 1942) revealed a fine interstitial fibrosis throughout the midportions of both lung fields, extending from the hilar areas toward the periphery, more extensive on the right side. Several coarse mottled densities were superimposed on this fine granular appearing lung pattern. There was a large soft tissue mass overlying the right heart border, extending from the right diaphragm toward the base of the neck. The upper segment of this shadow consisted of an air column overlying the trachea. In view of these findings mega-esophagus was suspected and confirmed by barium meal (Fig. 3). Subsequent examinations revealed that the mottled densities in both lung fields had partially resolved. The fine fibrosis did not show any changes.

After the esophageal disease was diagnosed the patient still would not admit any digestive complaints. On repeated questioning she finally stated that she occasionally had gas pains which were relieved by milk of magnesia.

*Comment.* This patient demonstrates the presence of acute and chronic pulmonary disease with mega-esophagus. Roentgenologically and clinically the patient developed an acute inflammatory process of the lungs during her postoperative course. It was shown roentgenologically that, in addition to acute pulmonary changes, there was rather extensive interstitial fibrosis in both lung fields. It is believed that bed rest and sedation may have favored aspiration of esophageal contents and produced the acute inflammatory changes.

From the clinical standpoint the almost complete lack of digestive symptoms is interesting.

CASE III. *Mega-esophagus and Pulmonary Fibrosis.*

H. C., a colored female, aged twenty-six, visited the out-patient department of Grady Hospital complaining of dysphagia, discomfort over the lower sternum, and shortness of breath. For three years she had noticed increasing difficulty in swallowing. She frequently regurgitated undigested food and would often be awakened at night choked by mucus and food flowing from her nose and mouth. During the last three years the patient had lost 25 pounds in weight. She had suffered from a cough of one year's duration which had become severe during the winter before hospital admission. She stated that her coughing was considerably worse during the night. There had been shortness of breath on exercise and a sensation of pressure in her chest.

Physical examination after admission to the hospital (October 18, 1943) revealed a slight diminution of breath sounds to the right of the spinal column. The lungs were otherwise clear and resonant. The examination of the heart revealed nothing abnormal. On deep palpation slight tenderness of the epigastrium was noted. The pelvic examination disclosed bilateral tubovarian masses. The fingers and toes showed clubbing with convexity of the nails. The red blood cell count was 4,450,000 per cubic millimeter, the hemoglobin content 7.7 gm. per 100 cc., the white blood cell count 7,800 per cubic millimeter. There were no abnormal urinary findings. The Kahn and Frei tests were negative. The electrocardiogram showed normal tracings. The vital capacity was 2.1 l. Cultures from the bronchial tree, obtained on bronchoscopy, revealed alpha-hemolytic streptococci and no acid-fast organisms.

Roentgenological examination revealed that the esophagus was considerably dilated. The lower portion of the esophagus was somewhat redundant and terminated in a funnel-shaped segment. The wall of the lower esophagus showed vigorous peristalsis and, occasionally, a small amount of barium passed into the stomach. The barium was retained in the esophagus for more than three hours. The lungs showed a fine interstitial fibrosis which was most marked in the base of the right upper lobe and in both lower lobes, producing a granular lung pattern (Fig. 4). No mediastinal shift was demonstrated. The excursion of the diaphragms was slightly diminished on both sides.



FIG. 4. Case III. Diffuse pulmonary fibrosis in right upper and both lower lobes. Slight widening of mediastinal shadow due to mega-esophagus.

Re-examination of the chest after two months revealed no definite change in the pulmonary findings. The roentgenological findings were confirmed by esophagoscopy.

*Comment.* In this case the association of mega-esophagus and diffuse interstitial pulmonary fibrosis is noted. Symptoms of dysphagia had been present for three years. For about one year the patient had had shortness of breath on exercise. Clubbing of the fingers and toes accompanied the chronic pulmonary changes which are believed to be the result of aspiration pneumonitis.

CASE IV. *Mega-esophagus and Aspiration Pneumonitis.*

A. L., a white female, aged eighteen, was admitted to Grady Hospital in December, 1938, complaining of difficulty in swallowing, of two years' duration. She had a choking sensation in her chest and would frequently vomit immediately after meals. Preceding this, the patient had suffered from colds, coughs, and gradual loss of weight. The physical examination and the laboratory findings were not significant.

Roentgenological examination (December 9,

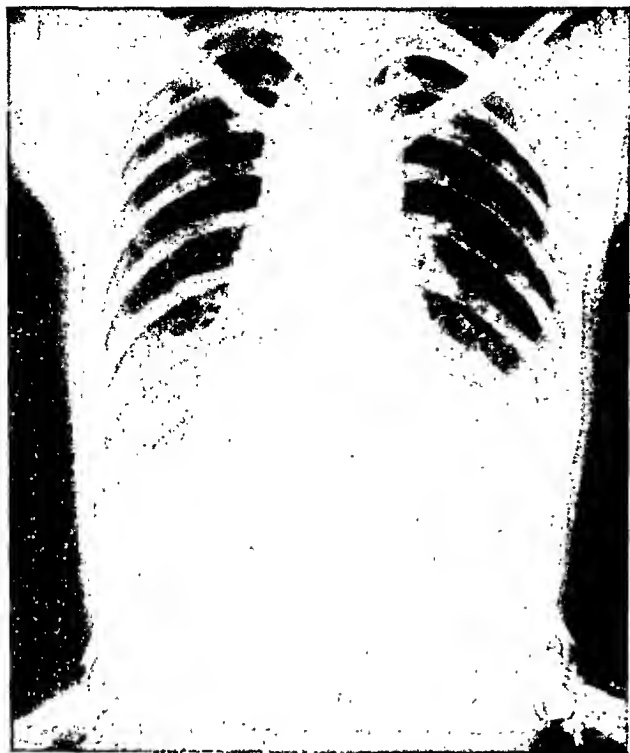


FIG. 5. Case IV. Aspiration pneumonitis, both lung bases. Air column in upper esophagus clearly visualized.

1938) revealed marked dilatation of the esophagus, characteristic of mega-esophagus. The roentgenological diagnosis was confirmed by esophagoscopy examination. After discharge from the hospital the patient was treated by esophageal dilatation in the out-patient department until June, 1941.

During the following winter she suffered from a very annoying, constant cough. In September, 1942, she became ill with fever, cough, chest pain, and chills. The patient consulted her family physician on November 7, 1942. A roentgenological examination on this day revealed coarse, mottled, confluent densities in both lung bases, obscuring both cardiophrenic angles (Fig. 5). She was admitted to another hospital where she remained for two weeks.

The patient was re-examined at Grady Hospital January 19, 1943. On roentgenological examination the dilatation of the esophagus had not changed in extent. No definite pulmonary pathologic condition was demonstrated. The patient stated, however, that she had been suffering from chronic cough during the winter months. There were no definite digestive complaints.

*Comment.* In a young adult the association of mega-esophagus and acute pneu-

monia is demonstrated. The presence of a very persistent chronic cough and frequent occurrence of colds are outstanding features in the history of this patient. During a febrile episode the presence of pneumonia in both lung bases was demonstrated roentgenologically. It is highly suggestive that the acute inflammatory process of the lungs was the result of aspiration.

#### CASE V. *Mega-esophagus and Bronchiectasis.*

E. F., a white female, aged twenty-eight, was first seen in the prenatal clinic of Grady Hospital in April, 1940, when she was six months pregnant. Her history revealed that she had the usual childhood diseases, including whooping cough and several attacks of "double pneumonia." For the past fifteen years the patient had been suffering from a chronic productive cough which was occasionally associated with febrile episodes. Her sputum was frequently blood stained and amounted to about half a cupful daily. During the last year she had frequent headaches in the region of the left frontal sinus. Since the first week of her pregnancy she complained of choking sensations in her throat and chest and inability to keep food on her stomach. The vomiting was often accompanied by severe coughing spells. The patient had had three normal pregnancies and one miscarriage, none of which was associated with similar digestive disturbances.

On July 2, 1940, the patient delivered a normal infant at Grady Hospital. A physical examination at that time revealed numerous coarse râles over both lung bases. After discharge from the hospital the patient was seen at intervals in the out-patient department, where she was treated for chronic sinusitis. She still complained of coughing, headaches, and thick yellowish nasal discharge. In June, 1942, her digestive complaints became much worse. She stated that she vomited everything she ate. The patient was re-admitted to the hospital and her condition improved considerably under medical treatment. The physical findings were unchanged. The red blood cell count was 4,200,000 per cubic millimeter, the hemoglobin content 11 gm. per 100 cc., and the white blood cell count 16,900 per cubic millimeter with a normal differential. The sputum showed numerous chains of gram-positive cocci, but no tubercle bacilli. A third and fourth hospital admission for study followed.

*Roentgenological Findings.* The first examination (August 8, 1940) revealed accentuation of the lung markings and fibrosis in both lung bases. An air column in the upper mediastinum, characteristic of mega-esophagus, is distinctly visible on this chest roentgenogram. A gastrointestinal examination on July 1, 1942, revealed marked dilatation of the esophagus. There was retention of the barium in the stomach though no organic obstruction was demonstrated. A bronchogram (April 2, 1943) demonstrated cylindrical dilatation of the bronchial tree of both lower lobes, the bronchi of the left lower lobe showing a tendency toward clubbing (Fig. 6). A distinct fluid level was seen in the mid-portion of the dilated esophagus.

*Comment.* This case illustrates the association of mega-esophagus with bronchiectasis. The respiratory symptoms were evident many years before the digestive symptoms were noted. This may be due to the fact that bronchiectasis preceded the development of mega-esophagus. However, since mega-esophagus may not produce significant clinical symptoms, it may well have developed at the same time or even have preceded the bronchiectasis.

#### DISCUSSION

*Clinical Manifestations.* A discussion of the symptoms and signs of mega-esophagus seems to be unnecessary, since the clinical features of this condition are sufficiently well known and have been described in excellent studies.<sup>4,6,10,12</sup> It should, however, be emphasized that the digestive disturbances—especially in the presence of respiratory symptoms—may appear so slight to the patient that he will frequently conceal their presence. They may be very vague and misleading. In 2 of our patients, symptoms of esophageal disease were detected only after the history of the patient was re-investigated. Another patient, even after the diagnosis was established, would not admit symptoms which would make the examiner suspect esophageal disease. It is of great importance to the clinician and to the roentgenologist to realize that mega-esophagus may exist even when clinical symptoms are minor or absent.



FIG. 6. Case v. Bronchogram demonstrating bilateral bronchiectasis. Note horizontal fluid level in dilated esophagus.

*Roentgenological Features.* Since the patient may present himself to the clinician or the roentgenologist with predominant respiratory symptoms, a gastrointestinal examination is frequently omitted. For this reason, it may be well to emphasize those roentgenological features which aid in the diagnosis of mega-esophagus by roentgenographic and roentgenoscopic examination, without the use of contrast medium. The enlarged esophagus produces a widening of the mediastinal shadow toward the right side, extending from the base of the neck to the diaphragm. Depending on the degree of dilatation, this shadow will partially or completely obscure the right heart border and cardiac pedicle. If the dilatation is of slight or moderate degree, the shadow of the esophagus may simulate the right heart border. The outline of the esophagus is not necessarily smooth. Tendency toward pouch formation may result in a scalloped or lobulated, sometimes bizarre appearance of the mediastinal shadow as is illustrated in Fig-

ure 7. Frequently the esophageal contents cast a peculiar mottled shadow in the mediastinum due to numerous small gas bubbles dispersed in the retained material. The visualization of a horizontal fluid level in the esophagus, as a result of retained viscid material, is an extremely helpful sign (Fig. 6). In the lateral view, a characteristic displacement of the trachea toward the

*Pathogenesis of Pulmonary Disease.* What explanation can be offered for the association of esophageal and pulmonary disease? Fistula formation between esophagus and trachea—as occasionally observed in esophageal carcinoma—was not demonstrated in any of our patients. Plummer and Vinson<sup>6</sup> stated that “nocturnal regurgitation, awakening the patient from sleep by food

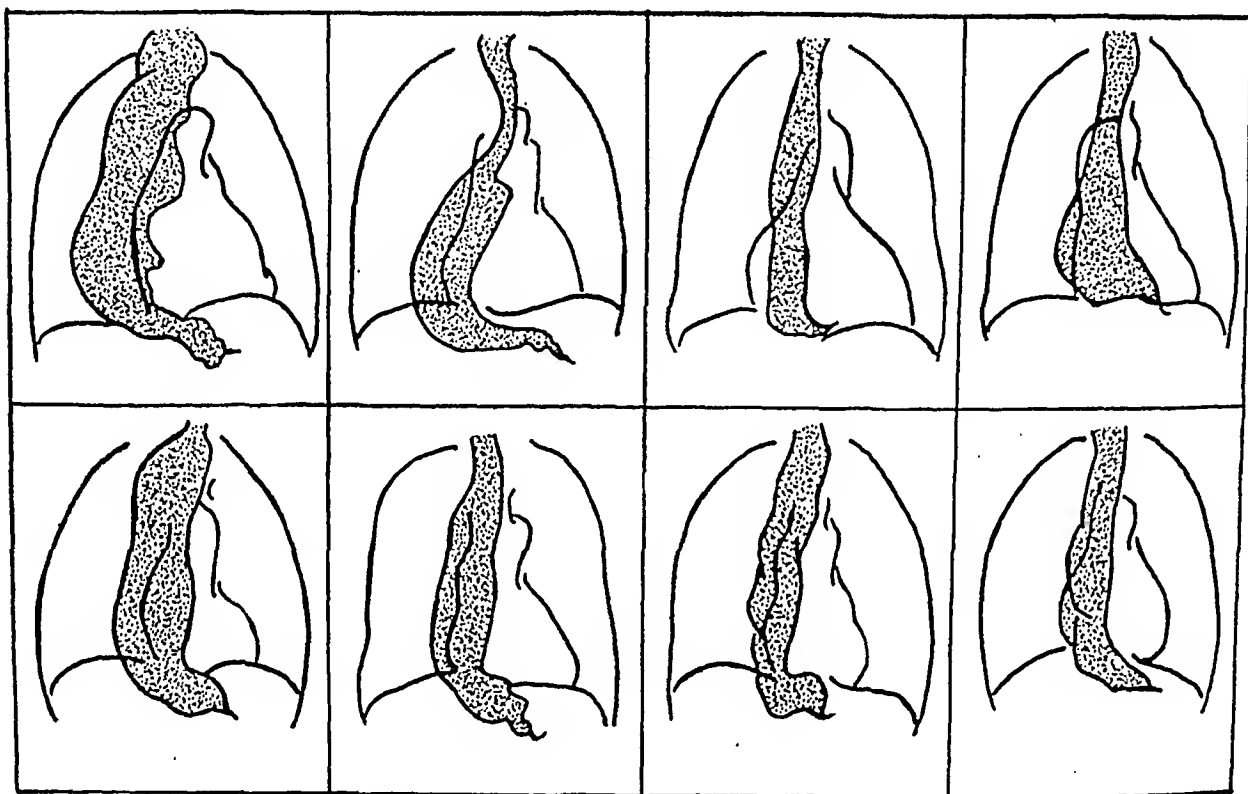


FIG. 7. Diagrammatic representation of 8 cases of mega-esophagus, showing the relationship between the right heart border and the dilated esophagus. Note variation in appearance of mediastinal shadow.

sternum is observed. Another sign of greatest diagnostic importance is the recognition of a double air column overlying the upper dorsal spine in the posteroanterior view. The central air column represents the trachea which is seen through the air column of the upper dilated esophagus (Fig. 8). Whenever one of these features is present on roentgenographic or roentgenoscopic examination, study of the esophagus by means of a contrast medium is indicated. This will readily enable the examiner to differentiate between esophageal dilatation and conditions simulating it, such as mediastinal disease and lesions of the spinal column.

or mucous running out of the mouth or into the nose, producing cough, or staining the pillow by food particles or mucus," occurred in almost one-third of their patients. It is readily conceivable that material regurgitated into the pharynx may be aspirated into the bronchial tree. It must be remembered that food may be retained in the esophagus for many hours, with ample opportunity for rapid multiplication of bacteria.

Pulmonary fibrosis, as observed in Cases II and III, is believed to be the result of aspiration pneumonitis, whereby mechanical and chemical factors may play an important rôle. Cummins and Williams,<sup>3</sup>



Baldwin,<sup>1</sup> and Warring and Rilance<sup>15</sup> made a most interesting observation by demonstrating non-pathogenic acid-fast organisms in the sputum of their patients. These organisms resemble, morphologically, tubercle bacilli from which they are differentiated by rapid growth on ordinary culture medium and development of coccoid forms. Baldwin isolated acid-fast bacilli from various fruits and vegetables and discussed the possibility of aspiration of these organisms from the esophagus into the bronchial tree.

Warring and Rilance do not believe that these organisms influence the character of the pulmonary disease. We believe that bacteriologic studies of these patients should be conducted with sputum studies obtained by bronchoscopy to avoid contamination with esophageal contents. Bronchoscopic sputum studies of Case III did not reveal any acid-fast organisms. It has to be admitted, however, that this patient was not examined during a febrile episode. It is entirely possible that bronchoscopic sputum studies of these patients may yield interesting results as to the bacteriology and mycology of this chronic pulmonary disease.

The association of bronchiectasis and mega-esophagus deserves special consideration. Reeke<sup>7</sup> explained the simultaneous occurrence of mega-esophagus and bronchiectasis in a nineteen year old patient as a congenital disorder. This conception is not generally accepted. The rôle which pulmonary and bronchial disease play in the pathogenesis of bronchiectasis has been stressed in excellent studies.<sup>2,5</sup> If we accept the occurrence of pulmonary fibrosis, atelectasis, and pulmonary and bronchial infection as a result of aspiration of esophageal contents, all factors thought to be necessary for the development of bronchiectasis are present.

In Case v, the digestive symptoms were evident for a much shorter period of time than the respiratory ones. This does not necessarily indicate that the development of bronchiectasis preceded that of mega-esophagus. As stated above, mega-esophagus



FIG. 8. Case IV. Double air column in upper mediastinum. Air column in trachea overlying spinous processes is seen through air column in upper esophagus.

may not produce characteristic symptoms but may remain more or less silent. An interesting speculation as to the cause of the association of mega-esophagus and bronchiectasis was offered by Schrire,<sup>9</sup> who suggested that a faulty neuromuscular mechanism may be an etiologic factor in the development of both conditions.

#### CONCLUSIONS

During the past four years fifteen cases of mega-esophagus were observed. Five of the patients showed evidence of pulmonary disease. As stated in the introduction, we are not justified in drawing definite conclusions as to the incidence of these complications from such a small series of cases. However, the occurrence seems to be greater than is generally appreciated. The recognition of this association of diseases is important from the clinical standpoint as far as prognosis and treatment of the patient is concerned. Early institution of all measures which enhance esophageal emptying will prevent aspiration of re-

tained esophageal contents into the lungs.

There are two groups of patients in which this combination of diseases may easily be overlooked, and to which we should devote our special interest. The first group comprises those patients who are known to have mega-esophagus. This diagnosis may dominate the clinical picture to such an extent that the examiner may pay little attention to the respiratory complaints of the patient. Yet these respiratory symptoms may be the result of pulmonary changes easily recognizable on roentgenological examination. Therefore, in all patients with mega-esophagus, the presence of pulmonary disease should be suspected and searched for. The second group consists of patients who present evidence of pulmonary disease the etiology of which is not fully explained. It is entirely possible that some of these are associated with unrecognized mega-esophagus.

It is suggested that both the chest and the esophagus be examined roentgenologically, whenever either is suspected of harboring a chronic disease process.\*

#### SUMMARY

1. The association of mega-esophagus with pulmonary lesions, such as lung abscess, aspiration pneumonitis, pulmonary fibrosis, and bronchiectasis is demonstrated.

2. It is believed that the pulmonary lesions are the result of aspiration of esophageal contents.

3. The incidence of pulmonary lesions in patients with mega-esophagus is thought to be higher than is generally appreciated. Pulmonary disease was demonstrated in five out of fifteen cases of mega-esophagus.

4. The roentgenological signs which aid in the diagnosis of mega-esophagus, without the use of contrast medium, are stressed.

5. The clinical importance of the association of pulmonary disease and mega-esophagus is discussed. Mega-esophagus may exist when digestive symptoms are minor or absent. It is suggested that pulmonary disease should be suspected in patients with mega-esophagus. In patients with pulmonary disease of unknown etiology, the presence of mega-esophagus should be ruled out.

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\* I am indebted to Dr. Avary M. Dimmock for follow-up studies on Case IV.



## PULMONARY SUPPURATION SECONDARY TO CARDIOSPASM

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THERE are many reports in the literature concerning pulmonary suppuration as a result of esophageal overflow and aspiration of the esophageal contents. The causes of esophageal retention are numerous, and among them may be mentioned cancer of the esophagus, stricture following the ingestion of caustics, pulsion diverticulum, constriction of the esophageal lumen by pressure from adjacent tumors, foreign body in the esophagus, and cardiospasm. Of these, cardiospasm, though a fairly common clinical entity, is rarely considered when an explanation is sought for a chronic pneumonitis of unknown origin. Vinson,<sup>11</sup> Sampson,<sup>7</sup> Baldwin,<sup>1</sup> and more recently Warring and Rilance,<sup>12</sup> have reported isolated cases in which the relationship between the two conditions is clearly shown.

Three cases of this nature have come under our observation during the past four years.

### REPORT OF CASES

CASE I. A. S., a white woman, aged fifty-three, was admitted to the hospital on January 21, 1939, complaining of cough and expectoration, present since November 24, 1938. The patient stated that she was taken ill on that day with what was described as grippe, the onset being chills and generalized muscular aches and pains. Cough and mucopurulent expectoration in a moderate degree developed promptly but subsided in about two weeks. Weakness and ease of fatigue persisted, however, and on checking her temperature the patient found that she had fever in the afternoon ranging up to 99.8°F. On January 10 she was taken acutely ill with prostration and high temperature, and on the following day had a fairly sudden onset of severe cough with rapid production of large amounts of bloody purulent sputum which in the first twenty-four hours amounted to approximately 8 oz. The sputum tasted very foul, but she was unable to state whether or not it

had a foul odor. At this time an aching pain first appeared in the right anterior chest, but later it became localized at the costal margin. Cough and expectoration had remained unchanged and night sweats had been noted since January 11. The patient had had some difficulty in swallowing food since 1936 when she began to choke at the table. This became progressively worse so that at the time of her admission it was difficult for her to swallow anything but liquids. The past and family histories were non-contributory.

Physical examination revealed a somewhat apathetic, elderly woman, coughing productively at intervals, and apparently acutely ill. The positive physical findings related to the right lung, where the percussion note was impaired above the level of the eighth dorsal spine, and tactile and vocal fremitus slightly increased posteriorly. The breath sounds were bronchovesicular throughout, and a moderate number of fine and medium tussic and post-tussic râles were heard in the intrascapular area above the level of the ninth dorsal spine.

Laboratory findings on admission were characterized by a leukocyte count of 27,800 cells of which 84 per cent were neutrophils. The red blood count was 4,300,000 and the hemoglobin content 13 grams per 100 cc. The urine examination and Wassermann reaction were negative. Repeated studies of the sputum were all negative for acid-fast bacilli. No spirochetes were found in the sputum and no predominant organisms were isolated.

A roentgenogram of the chest (Fig. 1) showed a dense area of infiltration in the right lung measuring 5 by 6 cm. Its central portion appeared excavated and contained a fluid level. With the aid of a lateral roentgenogram the area of disease was placed at the upper pole of the lower lobe.

A diagnosis of lung abscess was made and the patient placed on a regimen of postural drainage.

On February 1, roentgenological studies of the esophagus were carried out which showed a marked narrowing of the distal end of the

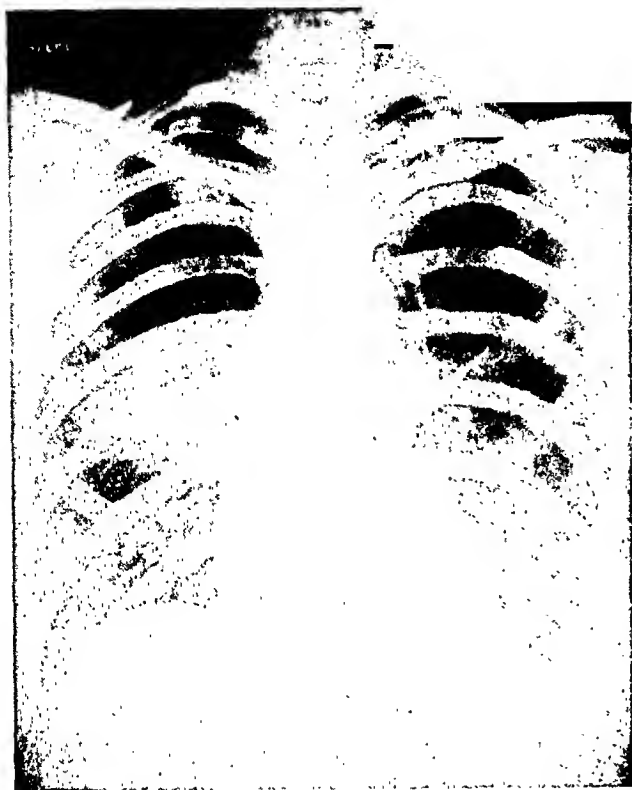


FIG. 1. Case I. Roentgenogram of the chest on admission. Note the area of infiltration in the neighborhood of the right hilum and the central rarefaction and fluid level.

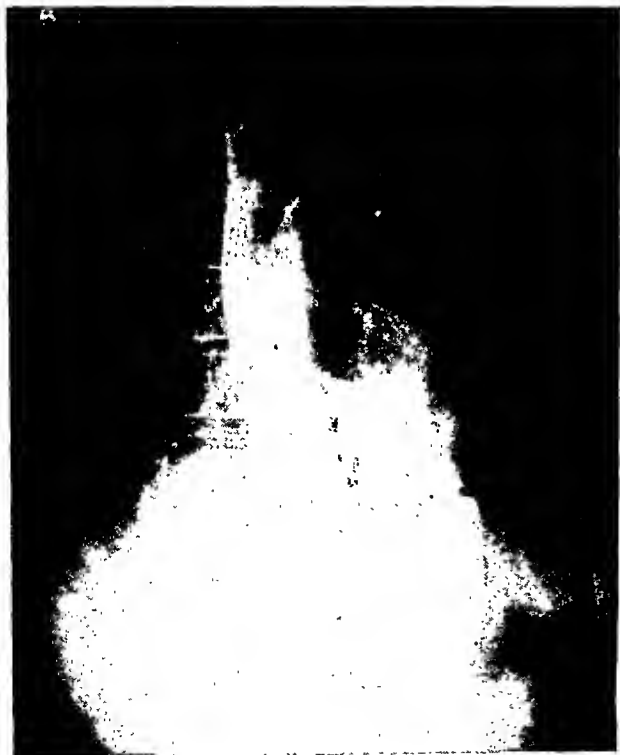


FIG. 2. Case I. Oblique view of the barium-filled esophagus showing the spasm at the cardia.

esophagus and a pronounced degree of dilatation above this level (Fig. 2). There were no irregularities in the outline of the esophagus to suggest the presence of a neoplasm. Only a very small amount of barium trickled through into the stomach during the course of the examination.

The patient continued to improve clinically, and serial roentgenograms of the chest showed progressive clearing of the area of infiltration and gradual disappearance of the cavity. Antispasmodics were administered but in spite of these she continued to have difficulty in swal-

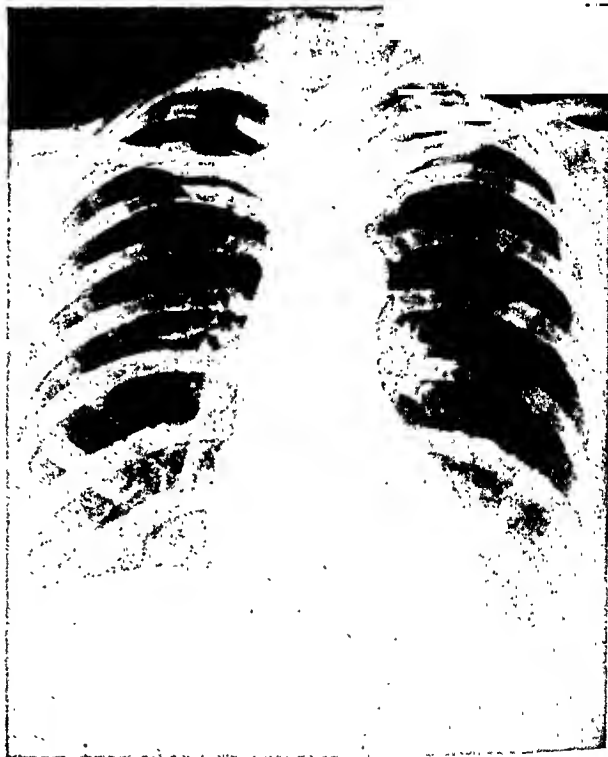


FIG. 3. Case I. Roentgenogram of the chest taken two days before discharge. The abscess has healed and only minimal fibrosis remains.

lowing. On May 17, esophagoscopy was performed and a careful examination of the entire esophagus revealed no evidence of an organic lesion. Esophageal bouginage was recommended and carried out.

At the time of discharge on June 24, 1939, the patient was entirely asymptomatic as regards the respiratory tract and a roentgenogram of her chest dated June 22, 1939, was normal except for the presence of minimal fibrosis at the site of the previous area of disease (Fig. 3).

CASE II. E. Y., white male, aged fifty-eight, was admitted to the hospital on August 28,

1941, complaining of cough and expectoration which had developed in February, 1941, in the course of an upper respiratory infection, and of shortness of breath on exertion which had its onset in March. In June, 1941, wheezing became apparent, and he entered a tuberculosis sanatorium for observation. A roentgenogram of the chest taken at the sanatorium showed some evidence of pulmonary infiltration, but after a few weeks of hospitalization he was discharged as non-tuberculous. The patient also complained of difficulty in swallowing both fluids and solid food, stating that he would get a sense of "filling up in the throat" and often became nauseated. He was rather vague as to the exact duration of his dysphagia but it apparently dated back at least six months. The past history was significant in that he had bronchopneumonia in 1921, 1930 and in the fall of 1940. The patient had lost 19 pounds in weight during the six months preceding admission to the hospital.

On physical examination the patient appeared slightly dyspneic but otherwise comfortable and not acutely ill. His state of nutrition was fair. The thorax showed a deep anteropos-

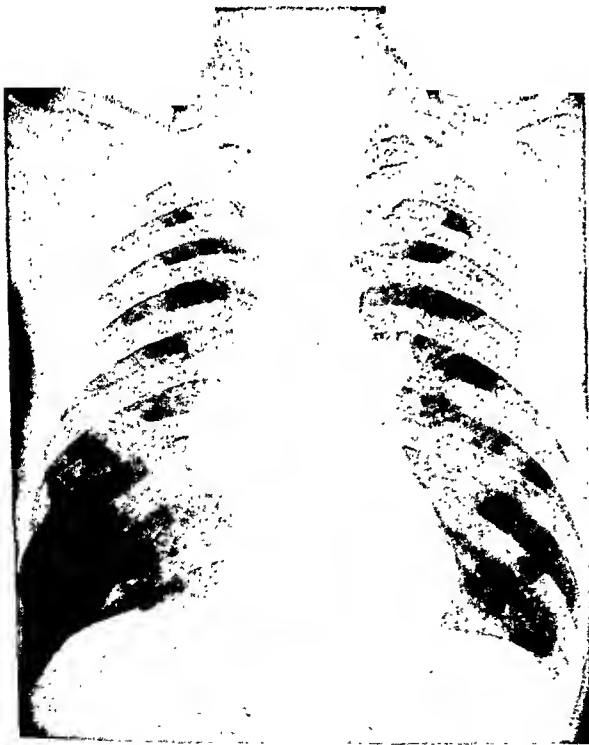


FIG. 4. Case 11. Roentgenogram of the chest taken on admission. Note the scattered small areas of infiltration, especially well seen on the right.



FIG. 5. Case 11. Appearance of the esophagus approximately fifteen minutes after the ingestion of barium.

terior diameter and rhonchi were present throughout both lung fields. The rest of the physical examination was negative except for the presence of a hydrocele on the left.

Laboratory examination revealed a normal blood count and a negative blood Wassermann. Urinalysis revealed the presence of a few hyaline and granular casts. Examinations of the sputum were microscopically negative for acid-fast bacilli and later the absence of tubercle bacilli was confirmed by cultural studies.

The clinical course in the hospital was marked by the absence of fever and the difficulty which the patient experienced in swallowing. On one occasion, he vomited soon after eating.

A roentgenogram of the chest taken on admission (Fig. 4) showed a few small mottled areas involving chiefly the mid-zone of the right lung at the level of the second interspace and at the level of the fifth anterior rib. Roentgenological examination of the esophagus revealed that the lower end tapered down to a fine point, but was free from any irregularity in contour (Fig. 5). In a period of roentgenoscopic observation of approximately ten minutes none of the barium entered the stomach. The examination



FIG. 6. Case III. Roentgenogram of the chest taken on admission to the hospital. Note the extensive infiltration in both lungs and the marked widening of the mediastinal shadows.

was repeated after the patient had been atropinized for four days and at this time there was still evidence of dilatation of the esophagus and spasm at the cardia but some barium was seen to enter the stomach.

On September 8 the patient was esophagoscoped and the esophagus was found to be smooth, dilated in its lower half, and filled with liquid contents and old food particles. Nowhere on the wall was there any evidence of neoplasm or ulceration. The cardia was passed without difficulty.

A second roentgenogram of the chest on September 15 showed some clearing in the areas of infiltration previously noted. Difficulty in swallowing persisted, however.

Esophageal bouginage was recommended and the patient was discharged at his request in order that he could obtain this form of therapy in the city from which he came.

Case III. H. D., white male, aged thirty-nine, was admitted to the hospital on June 2, 1942, with the chief complaint of cough, expectoration and ease of fatigue. The onset of these symptoms dated back to October, 1940, at which time the cough was minimal and the ex-

pectoration consisted of small amounts of mucopurulent material. One year later fatigue on exertion had its onset. One month before admission the fatigue became extreme and he began to suffer from dyspnea and vague symptoms of indigestion. During the month preceding hospitalization he lost 11 pounds in weight. On May 25, 1942, he first sought medical advice and a roentgenogram of the chest taken at that time, at another hospital, revealed changes which were thought to be suggestive of tuberculosis. The sputum, however, was found to be negative for acid-fast bacilli. The patient gave no history of chest pain or hemoptysis.

The past and family history, as first elicited, was not significant. Later developments, however, prompted a re-study of the past history and, on close questioning, the patient admitted that in 1923 he had had cardiospasm and had been treated by esophageal bouginage. He had attributed no importance to this episode, however, and since he had had no recurrences, he had "practically forgotten about it."

The patient appeared to be chronically ill and coughed occasionally during the course of the examination. The only positive findings related to the right lung field. Here there was slight impairment of the percussion note from the apex to the third rib, and the breath sounds were bronchovesicular in character. There was also a definite increase in vocal and tactile fremitus over the area of dullness but no râles were heard. Laboratory study revealed an erythrocyte count of 4.4 million cells with 13.2 grams of hemoglobin per 100 cc. and a leukocyte count of 14,600 cells with 80 per cent neutrophils, 14 per cent lymphocytes, 3 per cent monocytes and 3 per cent eosinophiles. Urinalysis and Wassermann reaction were negative. The sputum was repeatedly negative for acid-fast bacilli and was of interest in that it routinely separated within a few minutes after collection into three layers, the upper of which was oily in appearance and consistency, and stained red with sudan III.

A roentgenogram of the chest (Fig. 6) revealed evidence of feathery infiltration throughout both lungs. In addition, a dense shadow with a sharply demarcated lateral border and a moth-eaten appearance was found extending from the apex to the base and involving the inner zone of the right lung. Bucky roentgenograms in the posteroanterior and lateral positions were then taken and these showed the

mass to lie anterior to the dorsal spine and to be not homogeneously dense but presenting a mosaic appearance with alternating small round areas of increased and decreased density.

An esophageal examination was carried out next and it was soon evident that there was a large mass of impacted food in a greatly dilated esophagus (Fig. 7, 8 and 9). At this time only an insignificant amount of barium was seen to enter the stomach.



FIG. 7. Case III. After the ingestion of barium the widening of the mediastinum is seen to be due to a markedly dilated esophagus containing impacted food.

The contents of the esophagus were evacuated by repeated lavage and roentgenographic study was renewed. Initial roentgenoscopy revealed a fluid level in the esophagus at about the height of the ninth dorsal vertebra. Barium collected at the bottom of the esophagus and none passed into the stomach until one full glass of the opaque material had been ingested. By this time the fluid level in the esophagus had reached the fourth dorsal spine and the barium was then seen to flow slowly into the stomach (Fig. 9). An hour later approximately one-half of the opaque material originally ingested had passed into the stomach, and two hours later at least 75 per cent of the barium was in the stom-



FIG. 8. Case III. Same as Figure 7. Lateral view.



FIG. 9. Case III. Barium in the esophagus and stomach, showing the relationship of these two structures. Note the marked widening and displacement of the esophagus and the large area of spasm at the distal end of the esophagus.





FIG. 10. Case III. The esophagus has been evacuated by repeated lavage but the spasm persists as shown by the fluid level and the failure of the Rehffuss tube to enter the stomach.

ach but the esophagus still contained considerable fluid and barium.

A bronchoscopy was performed and revealed the posterior wall of the trachea to bulge inward. At scattered points in the airways there were accumulations of thick exudate which in all instances could be brushed away by sponge or removed by suction, the underlying mucosa appearing normal. Histopathological examination of some of the material obtained by bronchoscopic suction showed chronic inflammatory exudate containing striated muscle fragments, probably the remains of aspirated meat particles.

Esophagoscopy revealed a greatly dilated esophagus with smooth walls and no evidence of ulceration. The stomach was entered without difficulty and no areas of ulceration, stricture or neoplasm were encountered at the cardia.

Examination of the colon by barium was made to rule out the possibility of a co-existent megacolon even though the available data pointed to cardiospasm as the basis of the esophageal dilatation. This examination revealed a normal colon.

Repeated attempts were made to pass a Rehffuss tube into the stomach so that small fre-

quent feedings could be administered, but whenever the patient was checked roentgenoscopically it was found that the tube had coiled in the esophagus and that considerable fluid was present in this viscus (Fig. 10).

#### SUMMARY

Cardiospasm may result in pulmonary suppuration if the stagnant esophageal contents are aspirated. Three cases of this type are reported.

I wish to express my thanks to Dr. Clarence F. Graham for suggestions in the preparation of this paper.

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# RIB FRACTURES IN ATYPICAL PNEUMONIA

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## INTRODUCTION

**D**URING the course of an epidemic of the so-called virus or atypical pneumonia during the winter of 1942-1943, several instances of fractured ribs were noted in routine chest examinations. Many of these fractures were not detected at the time of the first examination and their presence was not appreciated until the subsequent development of callus formation on serial examinations of the chest to observe the progress of the pneumonia. A review of the current literature on atypical pneumonia did not reveal any previous description of the occurrence of rib fractures and for this reason it was thought desirable to bring this complication to the attention of roentgenologists in particular.

## HISTORY

The first case of rib fracture from indirect violence was reported by Graves<sup>5</sup> in 1833, according to Richardson.<sup>13</sup> Gurlt,<sup>6</sup> in 1860, collected 14 cases of spontaneous fracture of ribs following coughing. Tunis<sup>16</sup> in 1890, collected 38 cases of indirect rib fractures, 25 of which followed coughing. He noted that those ribs to which the diaphragm is attached were most commonly fractured and that the fractures were usually in the middle or anterior third of the ribs. Both he and Seilin<sup>15</sup> drew attention to one fact, that the fractures most commonly occurred on the left side in the lower six ribs.

In 1924, Palfrey,<sup>11</sup> in an article on rib fractures by muscular action, mentions several cases seen during an epidemic of severe tracheitis. These cases were encountered during World War I by the 22nd General Hospital, which was staffed by the Harvard Unit. Among the instances of rib fractures occurring following coughing in tuberculous patients are those described by Parenti,<sup>12</sup> Webb and Gilbert,<sup>17</sup> Howson,<sup>8</sup>

and Richardson.<sup>13</sup> Richardson described 20 cases of rib fracture associated with cough in a group of 1,903 patients in a tuberculosis sanatorium, and 10 additional cases in outpatients. Twenty-four of this group of cases had pulmonary tuberculosis, 3 had silicosis and tuberculosis, and 3 had chronic bronchitis.

Oechsli<sup>10</sup> summarized the literature in 1936 and reported 12 additional cases of rib fractures occurring in 2,000 admissions to a tuberculosis sanatorium. In all but one case the fractured ribs occurred in patients with far advanced tuberculosis. He described all fractures occurring in a line extending 4 cm. from the costochondral junction of the fourth rib obliquely caudad and laterally to the ninth rib in the mid-axillary line. This line corresponds to the attachment of the obliquus externus abdominis where it interdigitates with the serratus anterior muscle. He reasoned that the fractures were probably due to the opposing forces of these groups of muscles.

Sabbione<sup>14</sup> studied the incidence of rib fractures in pulmonary tuberculosis by reviewing 10,304 roentgenograms on 4,570 patients and discovered 19 cases, usually in older patients with advanced tuberculosis. He thought that the fractures were due to decalcification of the bones secondary to pulmonary tuberculosis.

Knoepp<sup>9</sup>, in 1941, reported a series of 917 fractures of the ribs occurring in 386 patients. Fifty-seven of these fractures were due to coughing or sneezing and of these 57, four occurred in patients with pneumonia. This is the only direct reference found in the literature to fractured ribs actually associated with pneumonia.

Atkinson<sup>1</sup> and Halliwell<sup>7</sup> reported cases occurring in patients convalescing from influenza. Breidenbach<sup>2</sup> states that "muscle violence is a more common cause of fractured ribs than is usually thought. It is

commonly reported in tuberculosis resulting from violent coughing." Brewster<sup>3</sup> reported a case of fractured rib occurring in a patient who coughed violently after choking while eating a walnut. Edgecombe<sup>4</sup> reported a case of fractured rib occurring from cough in a case of whooping cough. He reported that the bones of the patient in this case showed some decalcification.

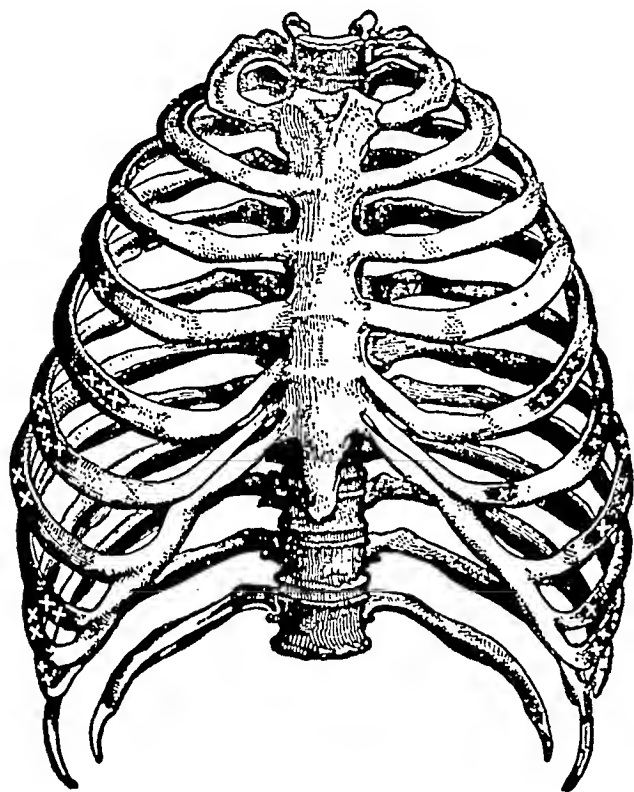


FIG. 1. A sketch of the bony thorax to illustrate the site of fractures in the cases reported. Each (x) indicates the site of a fracture.

Most of the standard texts on surgery mention the possibility of the occurrence of rib fractures from indirect violence such as coughing. None of the standard textbooks of medicine describe fractured ribs as a possible complication of pneumonia. As stated in the introduction, the occurrence of spontaneous rib fractures has not been described in any of the recent literature on atypical pneumonias.

#### METHOD OF STUDY

A consecutive series of 500 cases of atypical pneumonia occurring in a station hospital during the winter of 1942-1943

was reviewed. Nineteen of these patients had evidence of recent rib fractures. In 1 of these patients a definite history of trauma was elicited, but in all other cases trauma was excluded as a possible etiologic factor in the production of the fractures by careful questioning of the patients. Omitting the case with the definite history of injury the incidence of rib fractures in this series of cases was 3.6 per cent. A large percentage of these fractures was missed at the time of the original examination. On serial examination, during the observation of the course of the pneumonia, a fracture was commonly noted following development of callus. In these cases, a review of the original roentgenogram would usually disclose a definite fracture line. The appearance of the fracture lines and the subsequent development of callus left no doubt as to the fracture having occurred recently.

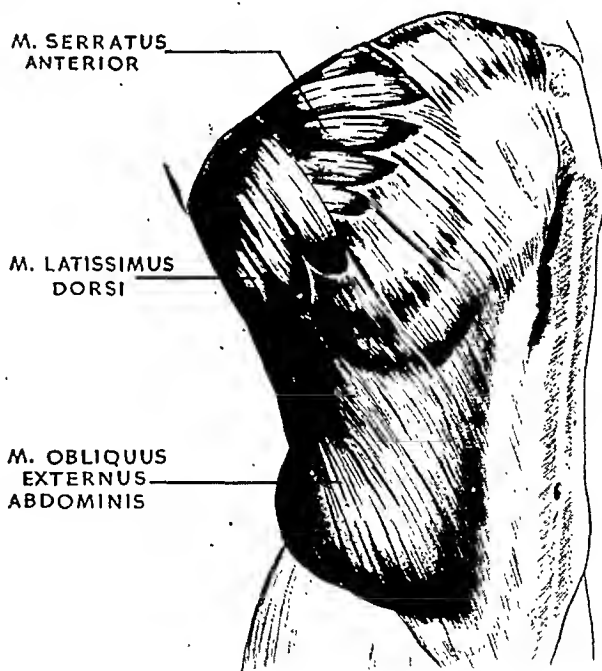


FIG. 2. A drawing of the interdigitations of the serratus anterior, latissimus dorsi and obliquus externus abdominis muscles to show the reason for the location of the fractures at the level of the insertion of these muscle groups. Compare this figure with Figure 1.



FIG. 3. Case 1. *A*, roentgenogram taken on January 22, 1943, shows an area of pneumonia at left base adjacent to left border of heart. Fractures of the sixth and seventh ribs on the left side are indicated by arrows. The fracture line indicated by the arrow in the right sixth rib could be seen on the roentgenogram. *B*, roentgenogram taken on March 25, 1943. After resolution of the pneumonia, dense callus formation can be seen about the fractures of the fifth, sixth and seventh ribs on the left side anteriorly and about the sixth rib on the right side near its anterior extremity and the fifth rib on the right in the anterior axillary line.

In several of the cases the fractures were quite apparent on review but at the time of the original examination the attention of the examiner was centered on the more obvious inflammatory process in the lungs. In 10 of the 18 cases the fractures were not recognized until a routine review of the entire series was made in a definite search for them. As some of these fractures were obvious and all of them could have been detected on a careful study of the roentgenograms, it is felt that by calling the attention of other roentgenologists to this complication omission of the detection of these fractures may be avoided.

#### DESCRIPTION OF FRACTURES

Figure 1 shows the site of the 34 fractures which occurred in this series of 18 cases of atypical pneumonia. It will be noted that the fractures were almost invariably grouped in the region of the interdigitation of the muscle fibers of the serratus anterior and the obliquus externus abdominis

muscles as shown in Figure 2. One patient had five fractures, 4 patients had three fractures, 4 patients had two fractures and the remaining 9 patients had one fracture. In 8 cases the fracture or fractures were on the right side, in 9 cases on the left side, and in the case with five fractured ribs the fractures were bilateral.

As shown in Figure 1, all fractures were in the anterior axillary or mid-axillary line. In the nineteenth case, in which there was a definite history of injury, the fractures were in the posterior portion of the ribs and were obviously due to direct violence. In 4 cases the rib fractures were on the opposite side of the chest from the pneumonic process and in the remaining cases the fractures were on the same side. The results in the series of cases lends credence to the argument of Oechsli<sup>10</sup> that the mechanism of the production of these fractures is due to the opposing forces of the serratus anterior and the obliquus externus abdominis muscles.

## TYPE OF PNEUMONIA

All patients in this series had the type of pneumonia which has been described clinically and roentgenologically as the so-called atypical pneumonia. Sputum examinations showed the presence of hemolytic and non-hemolytic streptococci and *Micrococcus catarrhalis* and only occasionally pneumococci. The pneumonias in this series of rib fractures were all located at the bases on the left side in 7, on the right side in 4, and bilateral in 7 cases.

## SUMMARY OF CASES

CASE I (see Fig. 3). The age of the patient was forty-one. Date of admission, January 22, 1943.

*Chief Complaint.* Bilateral pleurisy and cough.

*History of Present Illness.* Patient caught severe cold en route to camp six weeks previously and has been coughing since that time. Coughing, lifting or twisting body causes pain along both costal margins.

*Clinical Diagnosis.* Acute myositis.

*Roentgenological Diagnosis.* Left-sided atypical pneumonia. Fractures of the left fifth and sixth ribs in the mid-axillary line, the left seventh rib in the axillary line and the right fifth and sixth ribs in the anterior axillary line.

*Comment.* This case had the greatest number of fractured ribs and coincidentally the greatest degree of chest pain.

CASE II. The patient was aged forty-two. Date of admission, April 17, 1943.

*Roentgenological Diagnosis.* Right basal atypical pneumonia. Fracture of the left fourth rib in the anterior axillary line and the left seventh and eighth ribs in the axillary line.

*Comment.* This patient was psychotic and a satisfactory history was impossible. It was likewise impossible to make any evaluation of the patient's chest pain.

CASE III. The age of the patient was thirty-five. Date of admission, March 19, 1943.

*History of Present Illness.* Patient had no complaints on admission but had had a cold five weeks prior to admission.

*Roentgenological Diagnosis.* Atypical pneumonia, right base, Fracture of the left sixth rib in the anterior axillary line.

*Comment.* This is 1 of 2 cases in this series admitted without complaints, although showing definite roentgen evidence of atypical pneumonia and rib fractures. It has been frequently noted that cases of atypical pneumonia are picked up on routine

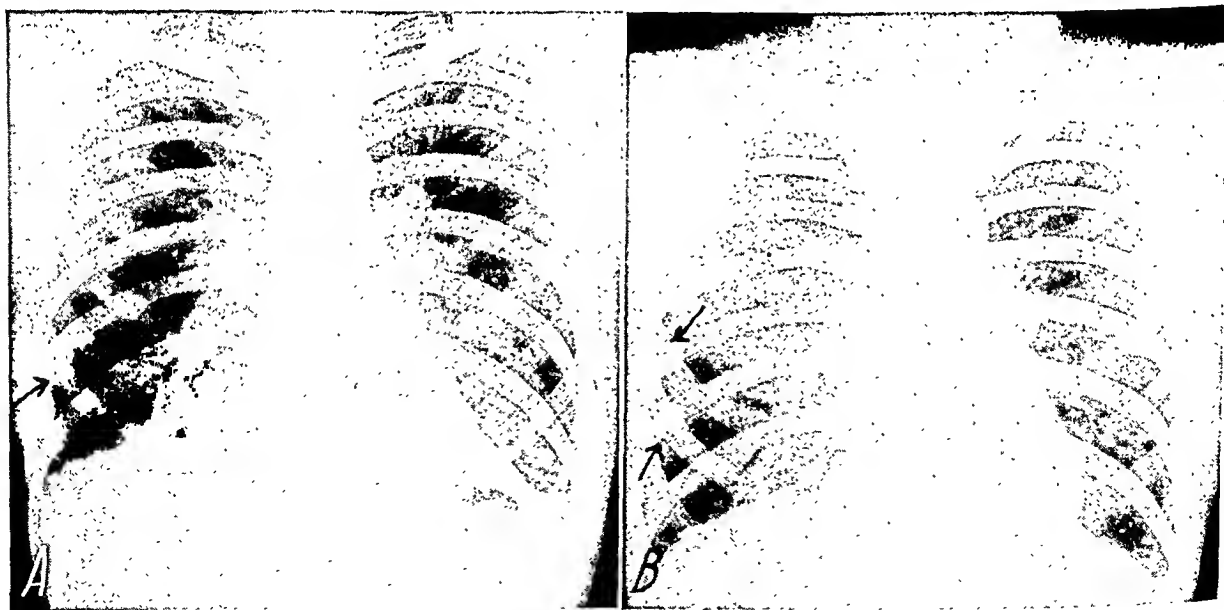


FIG. 4. Case VI. A, roentgenogram taken on November 13, 1942, shows bilateral basal pneumonitis with an incomplete fracture of the seventh rib on the right in the anterior axillary line as indicated by the arrow. B, roentgenogram taken on December 17, 1942, shows partial resolution of the pneumonitis with dense callus formation about fractures of the sixth and seventh ribs on the right as indicated by the arrow.

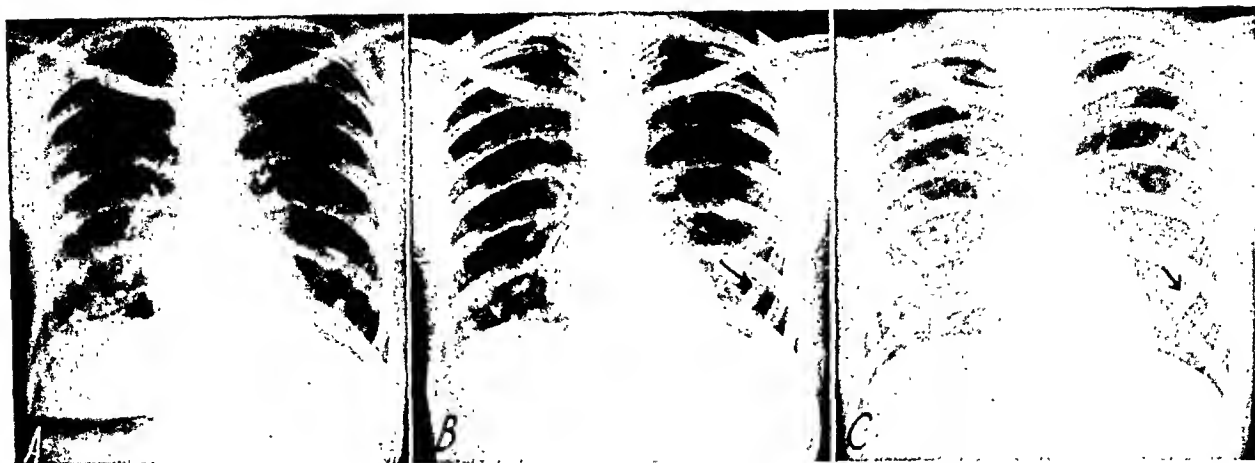


FIG. 5. Case VIII. *A*, roentgenogram taken on March 30, 1943, shows a bilateral atypical pneumonitis. No evidence of fractured ribs at this time. *B*, the pneumonitis is clearing on this examination which was made on April 12, 1943. There is an incomplete fracture of the fifth rib on the left side in the anterior axillary line as indicated by the arrow. *C*, roentgenogram taken on June 3, 1943, shows complete resolution of the pneumonia and moderate callus formation about the fractured rib.

examination in men who are apparently healthy and do not appear clinically to have a pneumonia.

CASE V. Patient, aged thirty-one. Date of admission, April 2, 1943.

*Chief Complaint.* Pain in the chest, slight cough.

*History of Present Illness.* Pain in the side for one week, subsiding at time of admission. Slight pains in the right axilla on deep breathing. Patient complained occasionally of pain in the right chest for three weeks following admission. Sputum contained non-hemolytic streptococci and *Micrococcus catarrhalis*.

*Roentgenological Diagnosis.* Atypical pneumonia, left base. Fractures of the right fifth, sixth and seventh ribs in the axillary line.

*Comment.* This is 1 of the 4 cases where the rib fractures occurred on the opposite side from the pneumonia.

CASE VI (see Fig. 4). Patient, aged twenty-two. Date of admission, November 17, 1942.

*Chief Complaint.* Cough and pain in the chest.

*History.* Cough present for ten days accompanied by slight chest pain. Pneumonia discovered on routine roentgenogram. Roentgenological diagnosis was bilateral atypical pneumonia. Fractures of the sixth and seventh ribs, right axillary line.

CASE VIII (see Fig. 5). Patient, aged nineteen. Date of admission, March 15, 1943.

*Chief Complaint.* Patient has had frequent

colds, chronic productive cough, pain in the left lower chest. Has had frequent admission to the hospital for these complaints. Roentgenological diagnosis was bilateral basal atypical pneumonia. Fracture of fifth rib in the left anterior axillary line.

CASE XI. Patient, aged nineteen. Date of admission, February 27, 1943.

*Chief Complaint.* Patient has had no complaints. Pneumonia discovered on routine chest roentgenogram.

*Roentgenological Diagnosis.* Atypical pneumonia, left base. Fracture, left sixth rib, anterior axillary line.

*Comment.* This patient had absolutely no complaints referable to his pneumonia or his rib fracture, and no complaints could be elicited following discovery of these chest lesions. It is remarkable how little symptomatology may be present with a fairly extensive degree of atypical pneumonia. The frequency of the discovery of areas of atypical pneumonia on a routine chest survey of apparently healthy individuals is probably due to delayed resolution. It has been noted that involvement of the lungs persists for some time after patients are clinically well in cases of atypical pneumonia.

CASE XVII (see Fig. 6). Patient, aged twenty-six. Date of admission, April 14, 1943.

*Chief Complaint.* Pain in the chest, dry cough.

*History.* Severe pain in the right chest on coughing and deep breathing, tenderness in the right chest. Chest pain persisted for one month following admission requiring frequent administration of codeine. Sputum contained hemolytic streptococci.

*Roentgenological Diagnosis.* Moderate bilateral basal atypical pneumonia. Fracture sixth rib, right anterior axillary line.

CASE XVIII. Patient, aged thirty-one. Date of admission, February 17, 1943.

*Chief Complaint.* Pain in the chest, cough, chills.

*History.* Persistent left-sided chest pain for two months. Sputum contained hemolytic and

right chest below the angle of the scapula. Has been in camp for one month and has had a cold, cough and expectoration.

*Roentgenological Diagnosis.* Right basal atypical pneumonia. Fracture of the sixth and seventh ribs on the right near their costovertebral junctions.

It will be noted from reviewing the roentgenograms of these cases that most of the pneumonic processes were slight in extent. No cases of rib fractures were noted in frank lobar pneumonia. The fractures all healed rapidly. In no case was there any apparent lack of calcium in the bones which

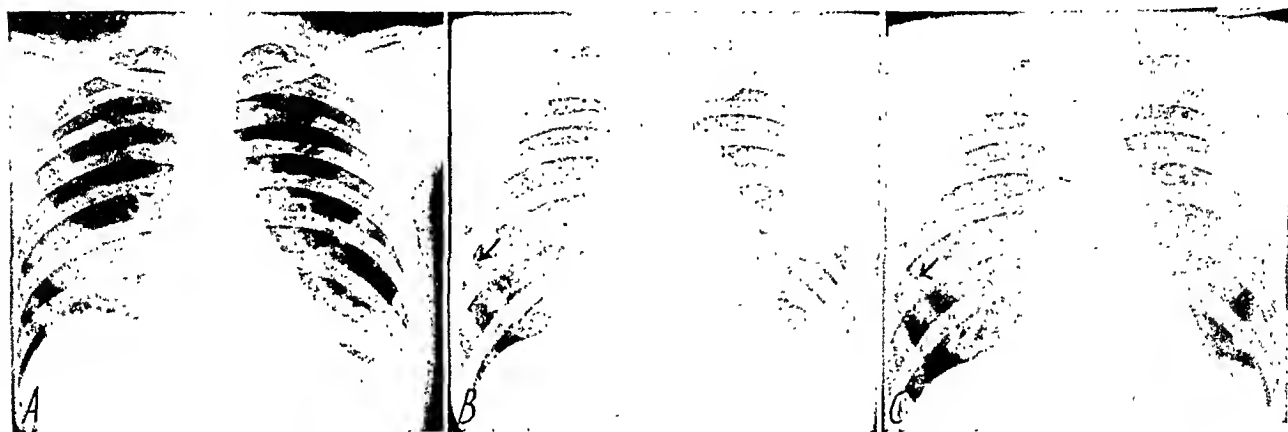


FIG. 6. Case XVII. *A*, roentgenogram taken on April 20, 1943, shows bilateral basal atypical pneumonia. No evidence of rib fracture at this time. *B*, roentgenogram taken on April 30, 1943, shows an incomplete fracture in the sixth rib on the right as indicated by the arrow. Some resolution of the pneumonic processes has occurred. *C*, roentgenogram taken on May 26, 1943, shows complete resolution of the pneumonic processes. There is now definite evidence of callus formation about the fractured right sixth rib as indicated by the arrow.

non-hemolytic streptococci and *Micrococcus catarrhalis*.

*Roentgenological Diagnosis.* Bilateral basal atypical pneumonia. Fracture, fifth rib, right anterior axillary line.

The following case is not included in the series of fractures due to indirect violence since the patient gave a definite history of injury.

CASE XIX. Patient, aged forty-one. Date of admission, January 26, 1943.

*History.* Patient was sent in following routine chest roentgen examination for discharge from Army. Stated he was carrying another soldier on his back two weeks prior to admission when he collided with another man. Had sharp pain in

could account for the occurrence of the fractures.

#### SUMMARY

Eighteen cases of fractured ribs were noted in a review of five hundred consecutive cases of atypical pneumonia. In 50 per cent of these cases the fractures were multiple, in four cases the fractures occurred on the opposite side from the pneumonia. All fractures occurred in the anterior axillary or axillary line. The reason for this has been postulated as due to the opposing forces of the serratus anterior and externus obliquus abdominis muscles as shown in Figure 2. The occurrence of rib fractures was not re-



lated to the severity of the pneumonia. Associated with atypical pneumonias is a severe, dry, irritating cough which is probably a factor in the production of the fractures. Excessive chest pain occurring in cases of atypical pneumonia should direct the search of the roentgenologist toward this complication. The attention of roentgenologists is directed to this complication of atypical pneumonia in order that the fractures may not be overlooked when study is centered on obvious inflammatory processes. This happened in many of the cases in the present series. This complication may explain many supposed cases of pleurisy in atypical pneumonia.

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# CONGENITAL ABSENCE OF RIBS\*

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**C**ONGENITAL absence of a single rib is an infrequent occurrence. Congenital aplasia of two or more consecutive ribs unilaterally is a rarity. Such a deformity may be present either without other anomalies or it is found more often in conjunction with defects of the pectoral muscles, vertebrae, or position of the scapula. Any combination of these aberrations may occur in the same individual.

The reports<sup>8,16,18,19,25,30</sup> recorded prior to the era of roentgenography, with the exceptions of the autopsied cases of Gripat,<sup>11</sup> Vrolick,<sup>31</sup> and Ardouin and Kirmisson,<sup>3</sup> are open to question. Following the advent of the x-ray the first proved case of congenital absence of a rib was reported by Freund.<sup>7</sup> The papers which have appeared since 1900 may be classified into three groups: (1) those in which one rib is missing unilaterally or bilaterally;<sup>1,2,6,9,12,13,17,20,21,26</sup> (2) those wherein two or more consecutive ribs are lacking on the same side;<sup>5,12,15,21,22,23,27,28</sup> (3) a miscellaneous group which does not fit either of the foregoing classifications.<sup>10,14,21,26</sup> The most common anomaly is contained in the first group.

## ILLUSTRATIVE CASES

### *Absence of One Rib; Congenital Scoliosis*

**CASE I** (No. 38-10204). White male who has been seen in this Clinic since the age of two. Spontaneous eight month birth. No history of congenital malformations in the family. The physical examination was essentially negative with the exception of congenital scoliosis with convexity to the left.

Roentgenographic examination revealed twelve ribs on the right, eleven on the left (Fig. 1). The sixth left rib is absent. There is wide separation of the fourth, fifth and sixth left ribs. The third and fourth thoracic vertebrae are wedge-shaped. Scoliosis with the apex of the curve to the left is present.

*Comment.* The absence of the left sixth rib does not correspond to the site of the

wedge-shaped vertebra. The sixth thoracic vertebra appears essentially normal in size and shape.

### *Absence of Two Consecutive Ribs Unilaterally; Scoliosis; Dextrocardia*

**CASE II** (No. 49,686). White female, aged eight months. No history of congenital abnormalities in the family. Spontaneous birth. Physical examination revealed a healthy child who was slightly underweight. The left thoracic wall bulged noticeably. Palpation of this area failed to reveal the presence of ribs covering the defect. A protuberance of the left anterior thoracic cage was evident.

Roentgen examination showed twelve normal ribs on the right (Fig. 2). There are ten ribs on the left, the seventh and eighth being absent. The transverse processes of the corresponding vertebrae are enlarged, and appear to have fused into one mass. The size and shape of all the thoracic vertebrae appear normal. A left thoracic scoliosis with the apex of the curve at the level of the sixth to the eighth bodies is present. The inferior angle of the left scapula is situated one rib higher than the right. The air shadow on the right extends to the ninth rib; on the left it is not observed beyond the sixth rib. The heart shadow is entirely confined within the right thorax.

*Comment.* This case is of special interest because there is complete aplasia of two ribs without apparent abnormalities in the shape of the vertebrae. A herniation of the thoracic wall is present. The dextrocardia is probably upon a mechanical basis, instead of an anomaly as is found in a normal thorax. From a roentgenographic standpoint the area of the left thoracic cage does not seem adequate to contain both the lung and heart.

### *Absence of Two Consecutive Ribs Unilaterally; Hemivertebra*

**CASE III** (No. 39-9926). White female who was first seen at the age of six months. Cesarean section at full term. She is the third living child

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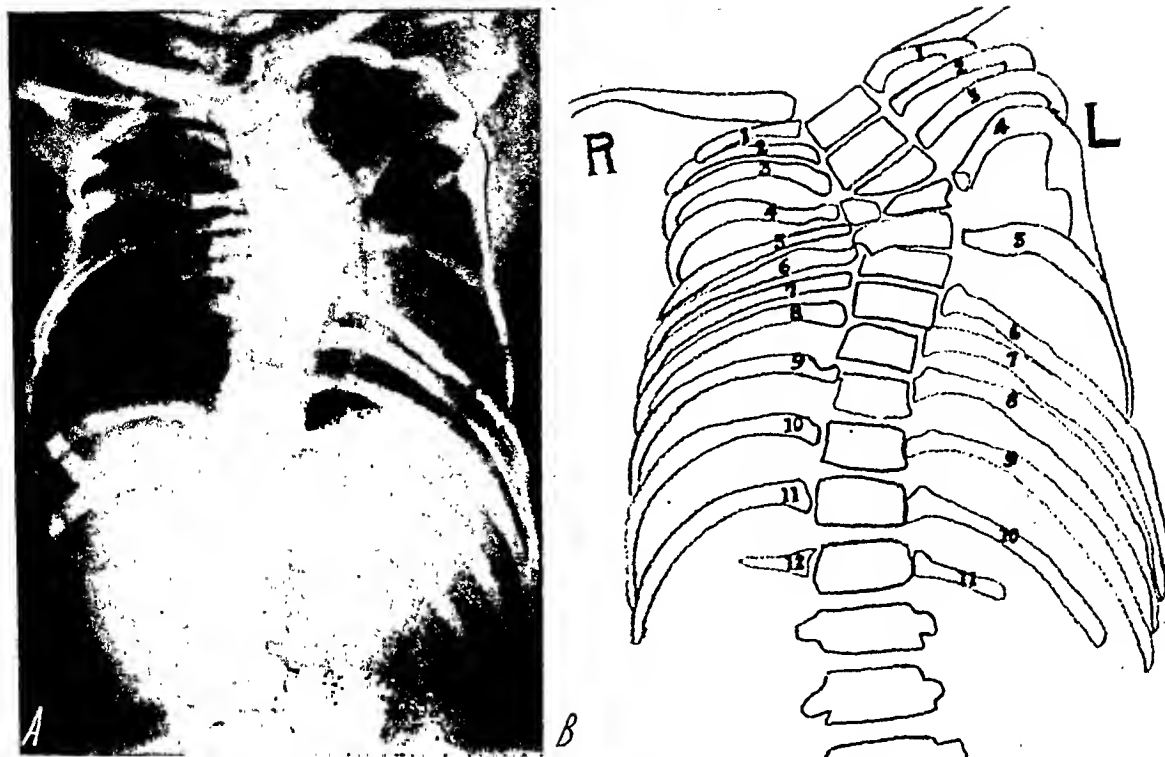


FIG. 1. *A*, roentgenogram showing absence of left sixth rib. See text.  
*B*, tracing of roentgenogram shown in *A*.

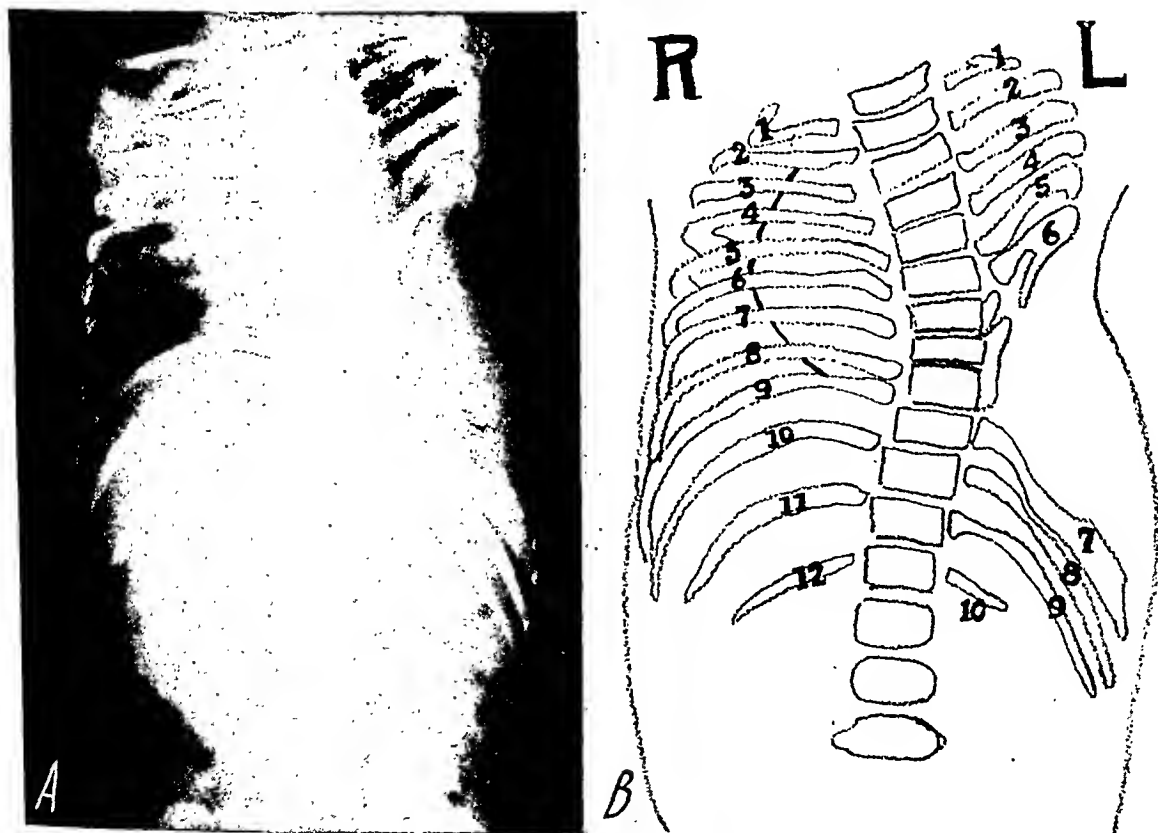


FIG. 2. *A*, roentgenogram showing absence of left seventh and eighth ribs. See text.  
*B*, tracing of roentgenogram shown in *A*.

of normal parents; the first was a hydrocephalic, and the second was normal. Physical examination revealed a marked congenital scoliosis with convexity to the right. No other congenital abnormalities were present.

Roentgenographic examination showed twelve ribs on the right, ten on the left. The left

ribs appear normal in size and shape. The right second, third and fourth ribs are absent. The fifth and sixth ribs are fused into one mass. There is malformation of the first to the third vertebral bodies, inclusive. The fourth thoracic vertebra is a definite hemivertebra. A cervical rib on the right is noted. The position of the left

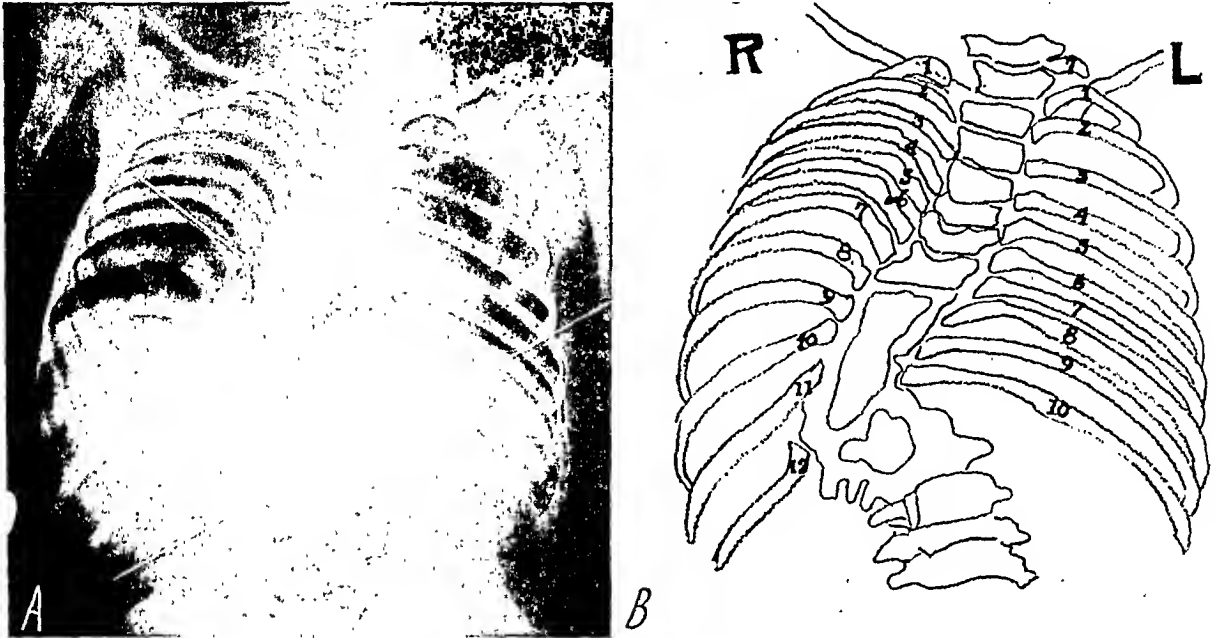


FIG. 3. *A*, roentgenogram showing absence of left eleventh and twelfth ribs. See text.  
*B*, tracing of roentgenogram shown in *A*.

eleventh and twelfth ribs are lacking (Fig. 3). There are no pronounced irregularities in the configuration of the ribs. Marked aberrations of the sixth thoracic to the third lumbar vertebrae, inclusive, are present, as manifested by hemivertebrae and spina bifida. An advanced thoracolumbar scoliosis with convexity to the right is noted.

*Comment.* The aplasia of the eleventh and twelfth ribs occurs at the site of marked congenital malformation of the vertebrae.

*Absence of Three Consecutive Ribs Unilaterally; Hemivertebra; Sprengel's Scapula*

CASE IV (No. 40-9220). White female who has been followed in this Clinic since the age of six. Spontaneous full term birth. No history of congenital deformities in the family. On physical examination elevation of the right scapula, scoliosis and deformity of the right anterior thoracic wall were noted.

Roentgen examination revealed twelve ribs on the left, nine on the right (Fig. 4). The left

scapula is normal; the right scapula is markedly elevated. Right thoracic scoliosis is present.

*Comment.* This case illustrates unilateral absence of ribs associated with congenital elevation of the scapula. Sprengel's scapula is not an infrequent associated deformity in these cases. The aplasia of the ribs occurs at the site of malformation of the vertebral bodies.

*Absence of Ribs Bilaterally; Hemivertebra*

CASE V (No. 38-25230). White male who was first seen at the age of five. Full term, spontaneous delivery. He was the fourth child of normal parents. No history of congenital deformities in the family. In addition to congenital scoliosis, left talipes calcaneus and dislocation of the left hip were present.

Roentgenographic examination revealed ten ribs on the right, eleven on the left (Fig. 5). There are no severe aberrations in the size and shape of the ribs. The tenth rib on the left is

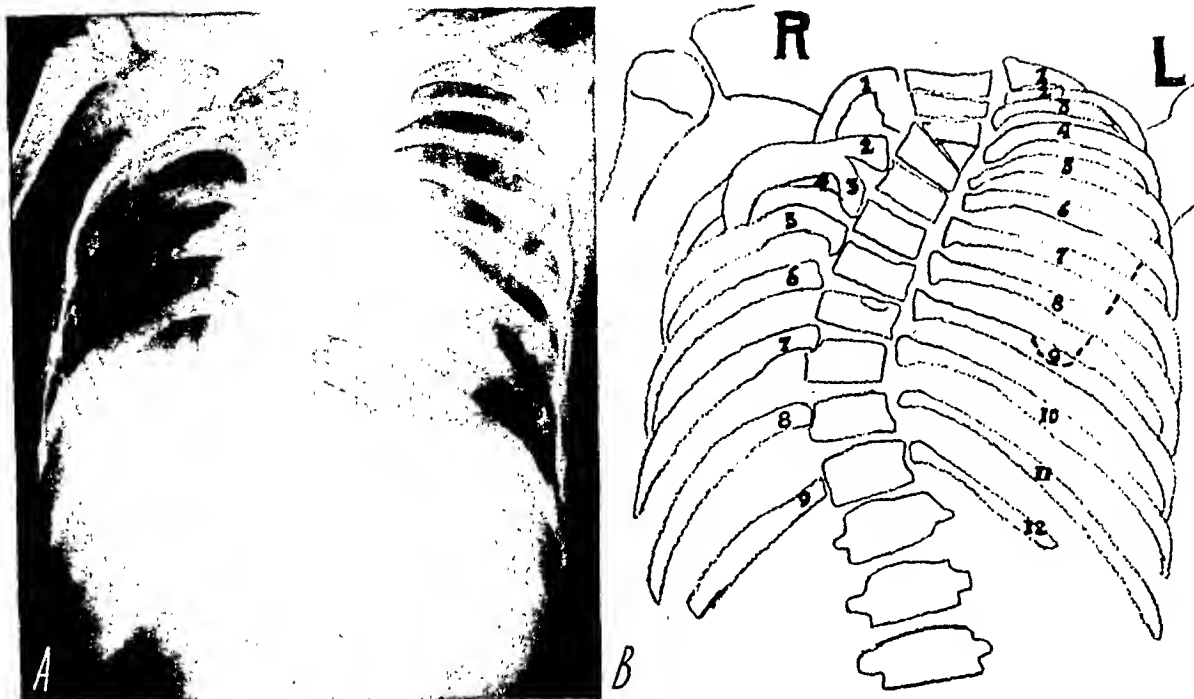


FIG. 4. *A*, roentgenogram showing nine ribs on right, twelve on left. See text.  
*B*, tracing of roentgenogram shown in *A*.

attached to a hemivertebra. A mild left scoliosis with the apex at the level of the hemivertebra is present. There are five lumbar vertebrae.

*Comment.* This case falls into the cate-

gory of the miscellaneous group of rib defects. In addition to aplasia of ribs, total suppression of the corresponding vertebrae is found.

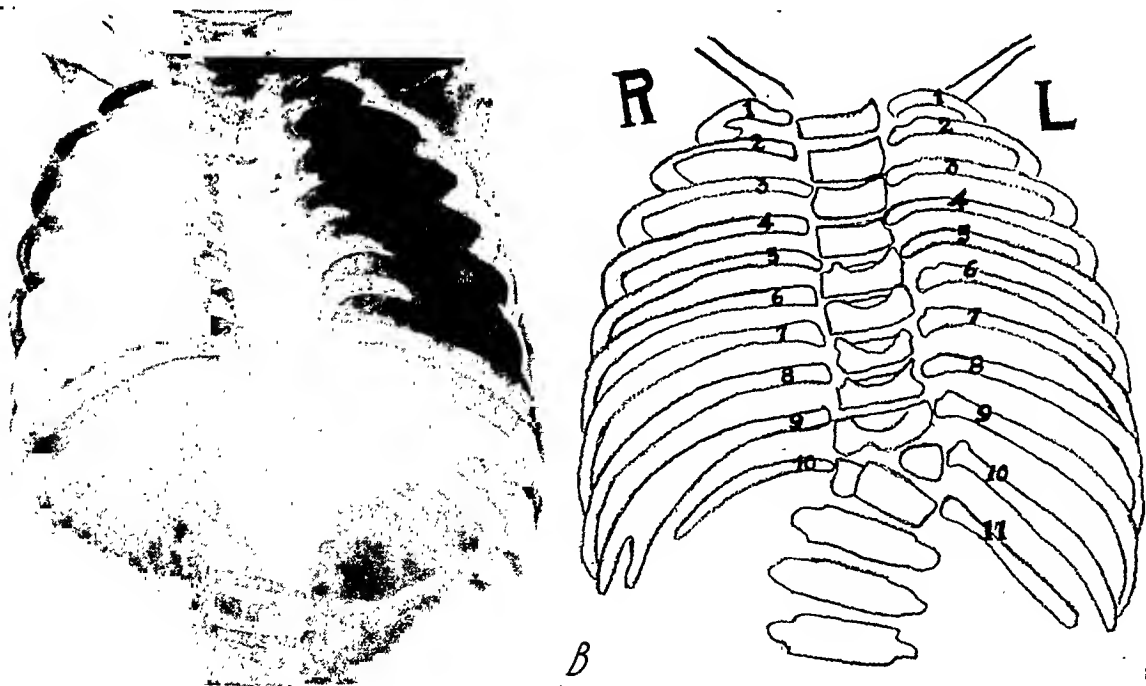


FIG. 5. *A*, roentgenogram showing ten ribs on right, eleven on left. See text.  
*B*, tracing of roentgenogram shown in *A*.

## DISCUSSION

The association of rib aplasia with defects of the vertebral body is explainable on the basis of embryology. The primordia of the definitive vertebrae are derived from the sclerotomic mesenchyme arranged in paired segmental masses alongside the notochord.<sup>4</sup> From each pair of primordia thus formed, growth takes place in three principal direc-

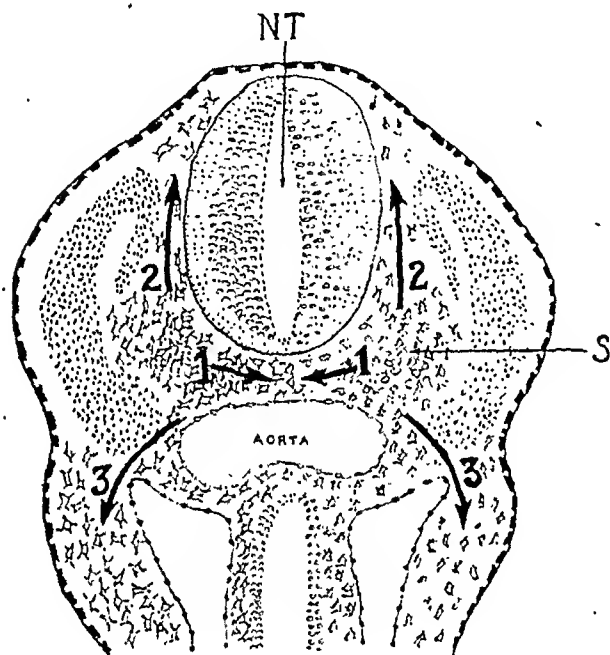


FIG. 6. Drawing showing differentiation of embryonic sclerotomic mass into various components of vertebra and ribs. (Modified after Arey.<sup>4</sup>) NT, neural tube; S, sclerotomic mass; 1, direction of sclerotomic growth to form vertebral body; 2, direction of growth to form vertebral arch; 3, direction of growth to form costal processes from which ribs originate.

tions: (1) mesially, the cells surround the notochord and establish the vertebral body; (2) dorsally, flanking the neural tube, to form the vertebral arch; (3) ventrolaterally, to provide the costal processes from which the ribs originate. The denser portion alone sprouts off the processes that become the vertebral arch and the rib (Fig. 6).

The intimacy of the primordium of a rib and its corresponding vertebra is thus clearly shown from an embryological standpoint. It is readily appreciated, therefore,

that any factor which may operate to inhibit the growth of the primordium of a rib may at the same time interfere with the primordium of the vertebral body or arch. Because of the common origin, it is surprising that all cases of aplasia of ribs are not accompanied by hemivertebra, or vice versa.

Ritter and Eppinger<sup>24</sup> believed that defects of ribs were caused by the pressure of an arm against the thoracic cage due to the lack of amniotic fluid. This hypothesis was favored by Thomson<sup>30</sup> and Kienböck.<sup>15</sup> The mechanical *modus operandi* was considered because the arm could be placed in the hernial defect of the thoracic wall. It is impossible to conceive that an arm could remain in one position sufficiently long during intrauterine life to suppress development of ribs, either partially or totally. Moreover, the frequent association of rib defects with vertebral anomalies entirely vitiates this hypothesis. The theory of amniotic adhesions is likewise highly untenable.

Stockard,<sup>29</sup> who worked with the eggs of the *Fundulus*, has advanced an explanation for malformation. He claims that there are critical moments in the development of every organ or part which are characterized by rapid cell multiplication. At such times this particular proliferating region is dominant, and may even exert a depressing influence over the growth of other parts. If this favorable moment for differentiation is not taken advantage of, the transient supremacy of the part is lost, and it in turn submits to depression by other parts assuming their dormant periods. The result is a reduced or imperfectly formed region which, having missed its opportunity, is never able to express itself completely or perfectly in competition with other parts now arrived at similar states of preferment. Each organ or part, therefore, not only originates from a definite primordium but also arises at a very definite moment that must be utilized then, if ever.

According to Stockard's theory<sup>29</sup> the most frequent factors which operate to evoke defects are changes in the conditions

of moisture, temperature, and oxygen supply. This theory appears to be the most tenable for the explanation of aplasia of ribs and associated vertebral anomalies when present.

## SUMMARY

Complete absence of ribs may be divided into three groups: (1) absence of one rib unilaterally or bilaterally; (2) aplasia of two or more ribs unilaterally; (3) a miscellaneous group. Any of these categories may be associated with anomalies of the vertebral body. Illustrative cases of each category are recorded.

The embryology of the rib and vertebral body is presented. The theories of etiology of complete aplasia of ribs are discussed.

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# ROUTINE CHEST ROENTGENOGRAPHY ON NEGRO INDUCTEES AT FORT BENNING, GEORGIA

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IN THIS presentation we are reporting the results of an analysis of routine chest examinations made on Negro inductees at the Armed Forces Induction Station, Fort Benning, Georgia. These statistics cover a period of thirty-one months.

The total number of cases examined is 102,241. Of these, 6,261 were examined in an eight month period, and these examinations were made on single acetate 14 by 17 inch films (stereoscopic pairs were used when deemed necessary). During the remaining twenty-three months 95,986 cases were examined with an Army photoroentgen unit, using 4 by 5 inch stereoscopic films. In those cases where a conclusive diagnostic statement could not be made, either a single or a stereoscopic pair of 14 by 17 inch films was obtained and, rarely, lateral films were made. Thus 93.8 per cent of our cases were examined routinely with the photoroentgen unit (Table I).

TABLE I

TOTAL NUMBER OF CASES EXAMINED: 102,247

	No. of cases	Percentage
Standard 14×17 inch film.....	6,261	6.2
Photoroentgen 4×5 inch stereo pair.....	95,986	93.8

As indicated above, all cases examined were Negro males, having an age range usually seen in any Army induction station. All individuals were given routine roentgenographic chest examinations. These Negro inductees came almost entirely from Alabama and Georgia with a scattered few claiming other Southern states as their

homes. We consider it unnecessary to discuss the method of operation of the photoroentgen unit used since this subject has been more than adequately discussed by de Lorimier,<sup>1,2</sup> Ehrlich, Schiller and Edwards,<sup>3</sup> and others. Interpretation of the roentgenograms was always carried out by an experienced roentgenologist. During the thirty-one month period covered by this study as many as six roentgenologists were used for film interpretation of the roentgenograms, but the great majority of the roentgenograms were diagnosed by one or two men.

Our criteria for acceptance or rejection on the basis of the chest roentgenogram are contained in MR 1-9.<sup>4</sup> We adhered most strictly to this set of rules.

We have attempted to divide our rejections into four large groups: (1) tuberculosis; (2) other lung diseases; (3) a miscellaneous group consisting of diseases of the thoracic cage, mediastinum, pleura, diaphragms, and dorsal spine; (4) abnormalities of the heart and great vessels.

In the first group it is seen (Table II) that there were 397 cases of active tuberculosis—activity being diagnosed on the presence

TABLE II

GROUP I. TUBERCULOUS LESIONS  
(Disqualified)

Type of lesion	No. of cases	Percentage
Active tuberculosis.....	397	0.38
Tuberculous calcifications.....	338	0.33
Tuberculous infiltration—apparently fibrotic.....	126	0.12
Totals.....	861	0.83

of cavitation, tuberculous bronchopneumonia, etc. There were 338 cases of tuberculous calcification that could not be considered acceptable under MR 1-9, and 126 cases of tuberculous lesions that were apparently fibrotic and were disqualifying, since they occupied an area of lung tissue 5 sq. cm. or larger. This gives a total of 861 cases, or 0.83 per cent rejected because of pulmonary tuberculosis. But, in addition (see Table III) there were 1,308 cases, or 1.27 per cent, deferred for six months because of the presence of tuberculous infiltration—apparently fibrotic, and occupying an area of lung tissue less than 5 sq. cm. in size. Since 0.83 per cent of the total cases examined were rejected for pulmonary tuberculosis, and 1.27 per cent were de-

TABLE III  
GROUP I(A). TUBERCULOUS LESIONS  
(Deferred for 6 mo.)

Type of lesion	No. of cases	Percentage
Tuberculous infiltration—apparently fibrotic (less than 5 sq. cm.).....	1,308	1.27

ferred for at least six months, we had a total of 2,169 cases, or 2.1 per cent, that were rejected at the time of examination because of pulmonary tuberculosis. Theoretically, all of the 1,308 cases of Table III should have been returned for possible induction after six months, but, unfortunately, due to circumstances beyond our control, we were unable to obtain an exact statistical follow-up on this group. Our general impression is that approximately 60 per cent of this latter group was finally considered acceptable (fibrotic lesion less than 5 sq. cm. that showed no change over a period of six months). Therefore, instead of considering that 2.1 per cent were rejected for pulmonary tuberculosis we feel justified in assuming that the correct figure would be closer to 1.3 per cent (arrived at by subtracting 60 per cent of the 1,308 cases in Table III).

TABLE IV  
GROUP II. OTHER LUNG DISEASES  
(Disqualifying)

Pneumonia.....	418
Pneumoconiosis.....	21
Spontaneous pneumothorax.....	14
Cystic lung disease.....	12
Bronchiectasis.....	6
Pulmonary tumor.....	4
Emphysema.....	4
Pulmonary abscess.....	3
Atelectasis.....	1
Boeck's sarcoid.....	1
Total.....	484
	or
	0.47%

This figure of 1.3 per cent compares favorably with that found in other inductee series.<sup>3,5</sup> To us, this was somewhat surprising in view of the generally lower economic status of our group in comparison with most other series and, of course, the racial factor. We would have expected a higher incidence of pulmonary tuberculosis as cause for rejection.

The second group of rejections consists of ten various lung diseases, of which pneumonia is, by far, the largest component (see Table IV). We had the surprisingly large number of 418 cases of pneumonia of various types. This is a good deal higher inci-

TABLE V  
GROUP III. MISCELLANEOUS GROUP, INCLUDING DISEASES OF THORACIC CAGE, MEDIASTINUM, PLEURA, DIAPHRAGM AND DORSAL SPINE  
(Disqualifying)

Pleural change.....	168
Enlarged non-calcified hilar nodes.....	46
Scoliosis dorsal spine.....	40
Mediastinal tumor.....	9
Eventration of diaphragm.....	9
Abnormal diaphragmatic elevation—undetermined cause.....	7
Rib tumor.....	4
Hiatus hernia.....	3
Tuberculosis dorsal spine.....	1
Total.....	287
	or
	0.28%

dence of pneumonia than we have been able to find in any other comparable series. We had 21 cases of pneumoconiosis, most of whom came from coal mining towns in Alabama. The 14 cases of spontaneous pneumothorax simply re-affirmed our belief that this is not a rare disorder. There were 12 cases of cystic lung disease, 6 cases of bronchiectasis, and 4 cases each of pulmonary tumor and emphysema of a dis-

TABLE VI

GROUP IV. ABNORMALITIES OF HEART AND GREAT VESSELS (Disqualifying)

Cardiac abnormalities, i.e. enlargement and/or abnormal configuration.....	333
Diseases of aorta.....	84
Pericardial disease.....	2
Total.....	419
	or
	0.41%

qualifying nature. There were 3 cases of pulmonary abscess, and 1 case each of atelectasis and Boeck's sarcoid. The total in the second group is 484 cases, or 0.47 per cent.

The third large group is a miscellaneous one that consists of diseases of the thoracic cage, mediastinum, pleura, diaphragm and dorsal spine (see Table v). In this group there were 168 cases of pleural change to a disqualifying extent. There were 46 cases of enlarged hilar nodes—all noncalcified. Unquestionably, some of these were tuberculous in nature but we feel that a good part were lymphomas (Hodgkin's disease, lymphosarcoma, etc.). There were 40 cases of scoliosis of the dorsal spine with a curvature greater than that permitted under MR 1-9. There were 9 cases each of mediastinal tumor and eventration of the diaphragm, and 7 cases of abnormal diaphragmatic elevation of undetermined cause. There were 4 cases of rib tumor, 3 of hiatus hernia, and 1 of tuberculosis of the thoracic spine. The total in this group is 287 cases, or 0.28 per cent.

Group IV (see Table vi) deals with disqualifying abnormalities of the heart and great vessels. There were 333 cases of abnormalities of the heart as to size and/or configuration. There were 84 cases of disease of the aorta—aneurysm, arteriosclerotic or hypertensive changes. There were 2 cases of pericardial disease—both manifested by calcification of the pericardium. The total in Group IV is 419 cases, or 0.41 per cent.

The total number of rejections—that is, the summation of Groups I, II, III, and IV and subgroup (a) under Group I is 3,359 cases, or 3.2 per cent of the total number examined (see Table VII). Utilizing the same reasoning that we applied to Table III (above) the exact percentage of all those permanently rejected would be about 2.8 per cent of the total examined.

DISCUSSION

We believe that our series may be of some value since it is essentially a mass survey of Southern Negro males of Army age, presumably in good health, as far as their local communities were concerned. Statistically,

TABLE VII  
SUMMATION OF CASES REJECTED AND DEFERRED

Group	No. of cases	Percentage
I.....	861	0.83
I (a).....	1,308	1.27
II.....	484	0.47
III.....	287	0.28
IV.....	419	0.41
Total.....	3,359	3.26

this series is biometrically significant because of the large number of cases examined. This certainly must represent an adequate "sample."

In looking over our figures we have been impressed by two facts: First, the incidence of rejectable cases of tuberculosis among this series of Negro inductees is apparently not significantly higher than in other series. One would expect a much higher incidence of rejectable tuberculosis in the Negro race and particularly among those Negroes of

the economic status found in Georgia and Alabama. Second, the number of ambulatory cases with pneumonia (418) is indeed striking. This means that 0.4 per cent of all our inductees had roentgenographic evidence of pneumonic infiltration at the time of examination. This is doubly surprising when one considers that these inductees presumably represented the healthy younger men of their respective communities. Why the Negro inductee in Georgia and Alabama should have such a relatively high incidence of pneumonic infiltration is difficult to understand. The answer may come with more large mass surveys in the future.

As noted above (Table 1) almost 94 per cent of our cases were examined by means of the Army photoroentgen unit, obtaining 4 by 5 inch stereoscopic films on each inductee, routinely. As we have also pointed out above, this was supplemented by standard acetate 14 by 17 inch films as considered necessary. As a general rule, we required supplemental films in no more than 1 per cent of the total cases examined. We believe that any detailed discussion as to the value and accuracy of 4 by 5 inch photoroentgenographic stereoscopic films is pointless. Those roentgenologists who have had any extensive experience with this method have absolutely no reservations as to the practicability and accuracy of this type of examination, particularly for large "screening" operations. Briefly, we are impressed by the following points: (1) quickness and ease in interpretation; (2) accuracy; (3) economy in use; (4) ease of handling, and (5) economy in storage.

All of these points have been adequately discussed by de Lorimier and others, yet we would like to stress points (1) and (2). We have found that it is much less tiring to interpret as many as 500 chest roentgenograms made by the photoroentgen unit than to "report on" only half as many single 14 by 17 inch chest roentgenograms. And we can do the 500 4 by 5 inch films more quickly than 250 14 by 17 inch films. As far as accuracy is concerned, we feel that

the 4 by 5 inch stereoscopic photoroentgenograms are only slightly less accurate than 14 by 17 inch stereoscopic roentgenograms and more accurate than a single 14 by 17 standard roentgenogram. We do not place much faith in the 14 by 17 inch paper film. Obviously, the accuracy of any method can only be attested to by the number of errors made in a practical application. We have, at this writing, discovered only 3 cases of tuberculosis that we can consider as having been "missed" at our Induction Station. In addition, there is 1 case with an obvious abnormal heart as to size and configuration (probably rheumatic mitral disease) that was called normal. There was also a case of histoplasmosis of Darling involving the lungs that we had called negative. On reviewing this case it was noted that the lungs had an appearance not unlike that seen in cases of interstitial fibrosis. Aside from these 5 cases we know of no other errors that we have made out of these 102,247 inductees examined. There may be other errors in diagnosis that will be discovered later but we feel more than satisfied with the accuracy of this method.

Finally, there is an important public health and economic aspect to this entire subject. We may safely conclude that a large number of these inductees who were rejected because of pulmonary tuberculosis and other chest diseases were probably the "silent sick" of the community. Many were spreading tuberculosis among relatives and friends, unaware of the nature of their illness. There is considerable hope that these men have been isolated from the rest of the community, and that many chronically ill may be rehabilitated in the future. The saving to the Government in terms of dollars and cents in discovering these various chest diseases is inestimable. Spillman<sup>6</sup> has demonstrated that the average inductee taken into the Army with tuberculosis ultimately costs the government \$10,000. It takes very little arithmetic to convince the unconverted as to the practicability and wisdom in obtaining routine chest roentgenograms on all inductees.

## SUMMARY AND CONCLUSIONS

1. An analysis of roentgenographic chest examinations on 102,247 Southern Negro inductees at Fort Benning, Georgia, has been presented.

2. The rejectable cases have been divided into four large groups as follows:

- (a) Tuberculosis, with a subgroup of tuberculous lesions deferred for six months.
- (b) Other lung diseases.
- (c) A miscellaneous group—including diseases of the thoracic cage, mediastinum, pleura, diaphragm and dorsal spine.
- (d) Abnormalities of the heart and great vessels.

3. A tabular summary of each of the four groups has been presented and a brief discussion of each group has been given where necessary.

4. It has been shown that there is probably no significant difference as to the incidence of pulmonary tuberculosis in our group of Negro inductees in comparison with other large groups.

5. An astonishingly high percentage of inductees with roentgenographic evidence

of pneumonia have presented themselves for examination.

6. The methods used in our chest examinations have been given.

7. The general value of the 4 by 5 inch stereoscopic roentgenograms made with the Army photoroentgen unit has been reaffirmed.

8. The importance of routine chest roentgenograms for all Army inductees has again been stressed.

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## PSEUDOMYXOMA PERITONAEI

### REPORT OF A CASE WITH UNUSUAL ROENTGEN FINDINGS

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THIS paper does not purport to be a comprehensive review of pseudomyxoma peritonaei, but rather the report of a case with certain roentgenographic findings which should be readily recognized whenever present. However, a few historical facts and salient features of the condition are worth mentioning. It was first recognized and described by Werth in 1884, and in 1901 Fraenkel observed the process in a male following the rupture of a mucocele of the appendix. Since that time at least 50 cases of appendiceal origin<sup>1,7</sup> and many more cases of ovarian origin have been reported. Rupture of a pseudomucinous cystadenoma of the ovary is by far the most common cause when one considers that these tumors comprise 75 per cent of all ovarian neoplasms,<sup>2</sup> and that the incidence of mucocele of the appendix based on the figures of Kelly, Castle, and Danreuther, is only 0.1 to 0.3 per cent.

Regardless of the primary source of the lesion the pathogenesis of pseudomyxoma peritonaei is essentially the same, although Chaffee and LeGrand<sup>1</sup> have made some attempt to differentiate the process arising from the appendix from that originating in the ovary. In both instances one premise must of necessity always exist: namely, the rupture of a sac or primary cyst containing mucinous or pseudomucinous material with the extrusion of the latter into the peritoneal cavity. This sac may be a pseudomucinous cystadenoma of the ovary, a mucocele of the appendix, or any blind pouch containing mucus-secreting epithelial cells. Soon after rupture of the primary cyst, the exudate, which is of a tenacious, mucoid character varying in color from a golden yellow to a dark brown depending upon the hemorrhage, fatty tissue, cholesterol, and

cellular detritus contained therein, becomes diffusely distributed over the entire abdomen. Both visceral and parietal surfaces of the peritoneum and also the mesentery become involved. Later on, generalized peritoneal thickening and cellular infiltrations occur with the formation of connective tissue producing firm adhesion bands. Simultaneously, there is proliferation of secondary tumors with the resultant production of multiple smaller cysts. Whether or not the mucoid material in itself is capable of giving rise to these secondary lesions is still an unsettled question, but some workers have strong experimental evidence in favor of the theory of cellular implantation.<sup>4</sup>

The presenting symptoms are usually those of a gradually enlarging abdomen, abdominal pain, or those of a partial bowel obstruction. Masson and Hamrick<sup>5</sup> state that the average duration of life after the onset of illness is 4.3 years, but report some cases still living eleven and twelve years after the first appearance of symptoms. Intestinal obstruction, pulmonary embolism and peritonitis following surgery, and intercurrent infection when the cysts perforate hollow viscera are listed as the most common causes of death. The following case illustrates many of the above mentioned facts, and in addition exhibits some characteristic roentgen findings.

#### CASE REPORT

H. M., female, aged twenty-seven, was admitted to another hospital on October 22, 1930, complaining of a large mass in the left side of the abdomen, which she had noticed for the past three weeks. During the past six months the menses had been scanty and irregular, and the last period, about two weeks ago, was accompanied by almost unbearable pain in the

left lower quadrant. For two years prior to the present illness the patient had complained of generalized and indefinite pains in this area. Past history revealed an operation on the uterus in 1921, the nature of which surgery could not be determined. In the same year an appendectomy and salpingectomy were performed. Two years later the right cornu of the uterus was resected, and at this time the patient was observed to have bilateral polycystic ovaries. Additional surgery prior to the present hospitalization included a cholecystectomy in 1925, and a dilatation and curettage following a miscarriage in 1926.

Physical examination revealed a white female of the apparent stated age, not appearing acutely ill. There were surgical scars in the right upper and both lower quadrants. In the left lower quadrant there was a firm, very tender, grapefruit-sized mass. The day after admission the abdomen was opened under spinal anesthesia through a midline incision, and an orange-sized cyst of the left ovary was found. In part the operative report stated: "The cyst was walled off with sponges and a trocar and cannula inserted. About one quart of dark brown fluid escaped. The anterior portion of the cyst wall was excised and the remainder marsupialized. A rubber drain was inserted into the cavity." On the fourth postoperative day the drain was removed, and the patient was discharged three days later. The pathological report of the tissue removed merely stated "cyst wall."

The patient was admitted to this hospital for the first time on December 6, 1932, complaining of pain in the right costovertebral angle of five days' duration which radiated to the mid-epigastrium. There were no genitourinary symptoms, however. Physical signs were essentially negative except for some tenderness and spasm in both right upper and left lower quadrants. The final impression was one of possible adhesions and she was discharged eight days after admission.

In November, 1935, the patient was admitted to this hospital for the second time still complaining of pain in the right costovertebral angle. Physical examination showed tenderness to percussion over both costovertebral angles, more marked on the right, and abdominal tenderness along the course of both ureters. There was a hard, nodular, indefinite mass in the left lower quadrant which was tender to palpation. Cystoscopy disclosed a cystitis and trigonitis,

but retrograde pyelograms were within average, normal limits and no stone shadows were demonstrable. A single flat roentgenogram of the abdomen showed a few small calcified areas opposite the transverse processes of the fourth and fifth lumbar vertebrae on the right and several rounded calcified densities along with a few phleboliths in the pelvic area. Unfortunately, this roentgenogram is not now available. On pelvic examination a diffuse tender enlargement was felt in the left fornix, and, when sigmoidoscopy was attempted, because of rectal complaints the instrument could not be passed higher than a distance of 6 inches. The final diagnosis was postoperative adhesions and the patient was discharged after fifteen days in the hospital.

On March 11, 1938, the patient was again hospitalized, this time in an institution other than the two mentioned previously. Her complaints were essentially the same as on previous admissions, but the possibility of a uterine cancer was entertained because of increased menstrual pain and menorrhagia. The following day a dilatation and curettage and amputation of the cervix were done. Concluding this, a laparotomy was performed, the operative report of which was as follows: "The abdomen was opened through a midline incision. A hard nodule  $\frac{3}{4} \times \frac{1}{2}$  inch was found under the fascia and removed for examination. There was a mass in the left pelvic area comprised of left ovary, tube, and broad ligament. This was studded with numerous nodules like the one found in the anterior abdominal wall, and they varied in size from that of the head of a pin to that of a plum. Several were removed for examination. Similar nodules were found in the liver and gall-bladder areas as well as in the omentum. Many adhesions were present and the pelvic mass appeared fixed. The abdomen was closed without drainage."

The pathological report on the tissue removed at surgery stated: "Gross: Uterine scrapings and wedge of cervical tissue show no gross abnormalities. There are two nodules measuring 1 to 1.5 cm. in diameter, which show central fibrosis and calcification, with a rim of soft pearly tissue resembling a lymph node. Smaller irregular nodules are completely calcified. Microscopic sections of uterine scrapings and cervical tissue show some luteal and late follicular phase of endometrium; microscopic sections of the nodules (Fig. 1) show a dense hya-



linized connective tissue enclosing small and larger gland-like spaces. These were apparently lined by epithelium, and in rare areas a few epithelial cells, degenerated and calcified, can be found. The cells are flattened or rounded now, and were apparently cuboidal or columnar, and in a single row. The gland spaces are regular and without papillary processes. The pathological process as seen in the nodules removed is apparently well under control and not active. Impression: Calcified pseudomyxomatosis peritonaei and luteal phase of the endometrium."

In October, 1942, the patient began to have cramp-like pains, which occurred at regular intervals a few days apart, in the region of the umbilicus. The attacks were sufficiently severe to cause her to "double up" and were of several minutes' duration. Hot vaginal douches were the most effective means of relieving this pain. In the early part of March, 1943, the attacks suddenly began to occur at much shorter intervals, sometimes as often as every fifteen minutes, and the pain became intensified immediately preceding a bowel movement. At this time she also had episodes of nausea, emesis of clear fluid, and twenty to thirty light colored, watery stools a day. Because of the known history of the case the patient was hospitalized and observed for a possible impending bowel obstruction. Besides the many surgical scars on the abdomen, examination revealed an orange-sized bulging of the abdominal wall to the right of and below the umbilicus. The mass appeared soft and there was no sensation of intra-abdominal mass beneath it. Generalized and rebound tenderness was present over the entire abdomen but more marked in the left lower quadrant. Rectal examination disclosed several small nodules in the anterior rectal wall and a shelf-like stricture on the anterior wall about 2 inches above the anal opening. A flat roentgenogram of the abdomen (Fig. 2*A*) showed multiple areas of cystic calcification, measuring from 0.2 to 1.3 cm. in diameter, scattered throughout the abdomen, but for the most part, in the pelvic and subphrenic areas. The calcified densities were discrete, and in areas where several did not overlaid each other, could be seen to be round and smooth. A lateral view (Fig. 2*B*) only tended to substantiate the disseminated character of the lesion. There were small collections of gas throughout large and small bowel, but inconclusive evidence was

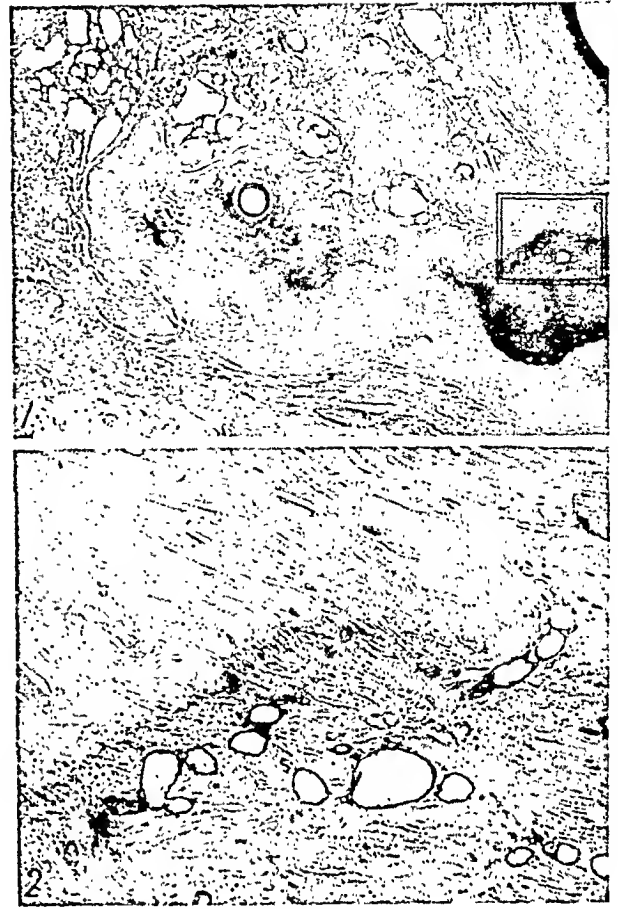


FIG. 1. *A*, a low power view showing the markedly fibrosed omentum with several small glands in cystic dilatation surrounded by firmly hyalinized and massively calcified connective tissue. In the upper field there are markedly dilated lymph vessels. Note the massive calcification of the entire wall of a cyst in the center. *B*, medium power view of the area marked on *A*. In some of the cysts a hazy, though mostly calcified, epithelial lining is recognizable, especially in the large cyst to the left, with some pseudomucinous secretion attached to the epithelial lining. Most of the walls, especially in the larger cysts, show complete calcification of the tunica propria.

present to warrant a diagnosis of bowel obstruction. When placed on a bland diet, antispasmodics, and sedation the symptoms subsided and the patient was discharged five days after admission.

#### DISCUSSION

The case presented exhibits the usual features of pseudomyxoma peritonaei and, in addition, an unusual if not extremely rare finding—calcification of the secondary peritoneal implants. In reviewing the re-

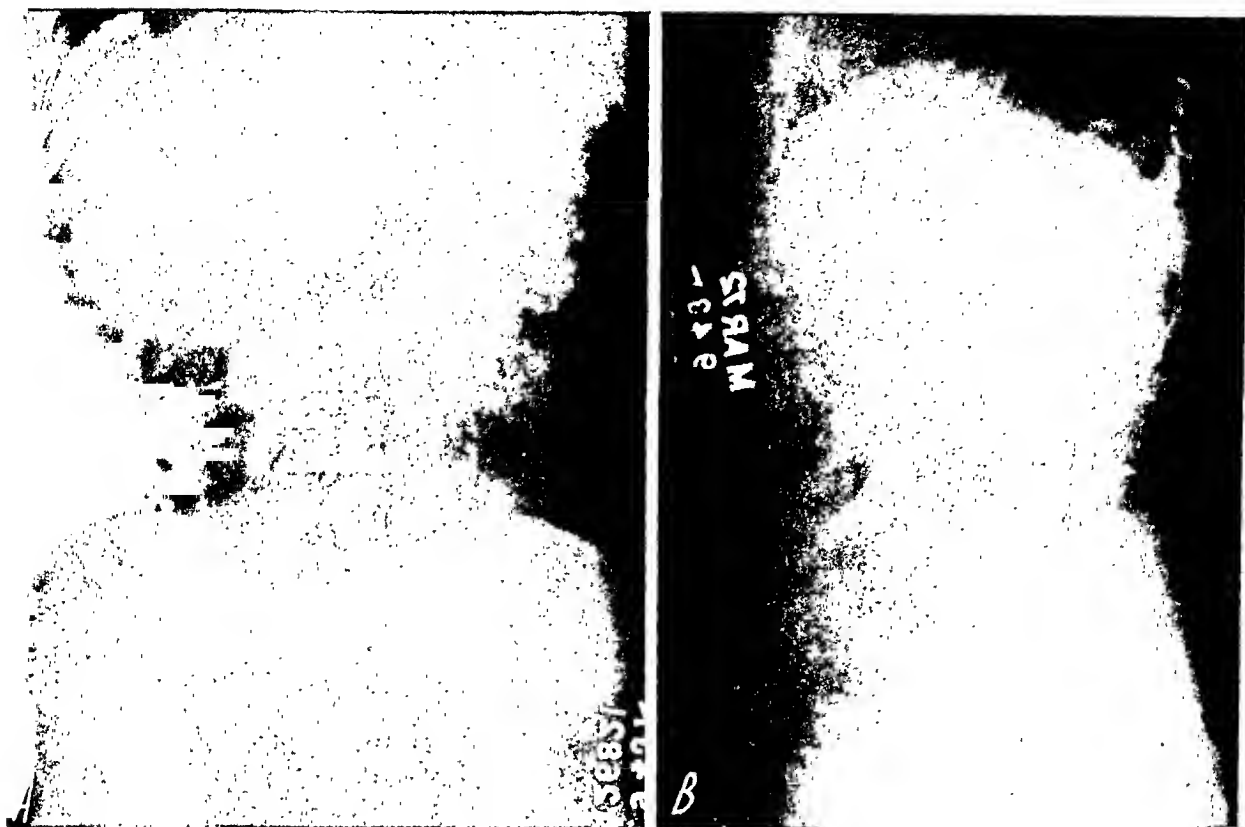


FIG. 2. *A*, anteroposterior view of the abdomen. *B*, lateral view of the abdomen.

cent literature we found only 2 cases, both reported by Pugh,<sup>6</sup> in which the roentgenographic findings were similar to those of the case presented. The first case, proved by laparotomy and showing the typical pathological changes of pseudomyxoma peritonaei, occurred in a male, aged thirty-two, and was probably of appendiceal origin. The second case, occurring in a female, aged fifty-three, was diagnosed as a probable peritoneal paraffinoma on the basis of a history of intra-abdominal instillation of some foreign substance to prevent adhesions and the pathologist's report of finding inflammable, meltable foreign substance in the cystic structure found at surgery. The author states that the latter case might well be one of pseudomyxoma peritonaei complicated by paraffinoma, as there was a history of previous surgery at which time one ovary and a cyst from the other were removed and "some ovarian material was scraped from the spine."

By the very nature of the lesion it is evident that the roentgen findings are limited

to the abdomen. As viewed in the roentgenogram, the peritoneal implants show the typical appearance of any cystic calcification; the shadows are round, have smooth borders, and are of a greater density at the periphery than at the center. The lesions are multiple and discrete, although some may be in such proximity with each other as to give a lobulated appearance. They vary in size from a few to several millimeters in diameter and are widely distributed throughout the peritoneal cavity. Concerning their location, the greater number observed in the pelvic area can be readily explained by the fact that this region is the one most affected at the time of rupture of the primary cyst.

Having stated the general roentgen appearance of the lesions in this case, let us now consider other types of intra-abdominal calcifications which might be included in a differential diagnosis. Peritoneal paraffinoma with subsequent calcium degeneration might exhibit a similar roentgenographic picture. In these cases the correct

diagnosis may depend entirely upon the history. Calcified secondary echinococcus cysts would probably have a similar appearance in the roentgenogram, but here the presence of the much larger mother cyst in the liver should suffice to make the diagnosis. Calcified mesenteric nodes are apt to be fewer in number, show a greater and more uniform density, and exhibit more irregular borders. Phleboliths, biliary and urinary calculi, and localized calcification in uterine fibroids should readily be differentiated by their size, locality and difference in density. Enteroliths and fecal concretions containing sufficient calcium salts to cast a shadow are fewer in number but may cast similar shadows. Their location within the alimentary tract can be demonstrated by stereoscopic roentgenograms following contrast enemata. In a like manner, opaque medication and retained barium in diverticula may be also differentiated. We are not aware of calcification in endometrial transplants or abdominal metastases secondary to colloid carcinoma of the ovary.

In addition to the singular roentgenological aspects, the case presented exhibits a rational correlation between these findings and the clinical course of the disease. Although the condition was not accurately diagnosed until 1938, it will be remembered that the rupture of the ovarian cyst occurred in 1930, and that the first roentgen evidence of peritoneal affection was observed five years later. In the eight years following this observation the lesions have shown a marked increase in calcification. According to Ewing,<sup>3</sup> calcification is a strik-

ing feature of the epithelial elements of certain tumors, indicating a limited degree of growth capacity and a tendency toward spontaneous regression. The patient whose case is reported is still alive and well, now thirteen years after the onset of symptoms. Undoubtedly she will experience recurrent episodes of low grade bowel obstruction in the future, but the growth of the secondary cysts has in all probability ceased.

#### CONCLUSIONS

1. A brief résumé of the history and pathogenesis of pseudomyxoma peritonaei is presented.
2. A case with unusual roentgenographic findings is reported.
3. The roentgen findings, differential diagnosis, and clinical course of the disease are discussed.

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# DIVERTICULUM OF THE STOMACH

## CASE REPORT

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**D**IVERTICULA of the stomach are interesting but infrequent findings, only 150 cases being reported so far in the literature.<sup>4</sup> Incidence is given by all writers on this subject as far below 0.5 per cent of all gastrointestinal examinations performed.<sup>19</sup> Only one author was found to have reported an incidence of 0.65 per cent of all his gastrointestinal examinations.<sup>27</sup> Regarding the order of frequency of diverticula of the alimentary tract, incidence of gastric diverticula is placed almost at the end of the list,<sup>21</sup> preceding in number only the exceedingly rare diverticula of the jejuno-ileum.

There is much want of clearness in classifying these abnormalities. The rigid differentiation between congenital and acquired gastric diverticula, the latter said to be caused either by pulsion or traction,<sup>2,26</sup> now seems to be abandoned in favor of a tripartition: congenital, acquired and false. The first two categories are called true diverticula because they contain all layers of the stomach wall, whereas the false diverticula show at least one layer missing.<sup>9,21</sup> A third classification differentiates the true diverticula, all of them probably congenital, from the false ones, all of the latter acquired, either by pulsion or, more frequently, by traction.<sup>4</sup> Martin<sup>12</sup> is of the opinion that all diverticula of the pulsion type are congenital, those of the traction type acquired.

We do not believe that these attempts to classify gastric diverticula rigidly along pathologico-anatomical lines can be accepted from a clinical point of view. For the clinician, it does not make much difference in his attitude toward the case whether or not all coats of the gastric wall are present. Furthermore, it seems to be doubtful whether all so-called false diverticula with

one or more coats of the stomach wall missing are due to a break in the gastric wall resulting from disease, either inflammatory or ulcerative or neoplastic. Finally, it is impossible for the diagnostician to establish from the roentgen evidence a firm decision as to what pathologico-anatomical group his case belongs. There are only two points which matter to him: (1) that the diagnosis of a diverticulum on roentgen examination is correct; (2) whether and how many of the symptoms complained of can be referred to the diverticulum found roentgenologically.

It is certain that the definitely congenital diverticula are extremely rare, so rare that only the so-called pancreas diverticula of Nauwerck<sup>15</sup> once were believed to be congenital.<sup>2</sup> It should be noted that Rivers, Stevens and Kirklin,<sup>21</sup> referring to 14 proved cases of true diverticula of the stomach, did not find pancreatic tissue in any of their cases.

The most frequent localization of gastric diverticula is in the cardiac region.<sup>4,19,20,21,29</sup> Next in frequency are the diverticula in the pyloric region.<sup>4,17,19,21,29</sup> Gastric diverticula some distance from the pylorus are least frequently found.<sup>19,21,29</sup>

We had the opportunity some time ago to observe the following case:

Mrs. H. D. S. (No. 28342), aged seventy-one. Some digestive disturbance and chronic constipation since first pregnancy in 1902. Appetite has always been good. When she eats raw or coarse food, she complains of gas, feels some soreness in the pit of the stomach and much discomfort in the lower bowel. Otherwise no stomach or abdominal complaints. General condition good. Blood pressure 135/75. Roentgen examination revealed a large diverticulum at the lesser curvature near the cardia. The entrance of the diverticulum is wide and a gas-bubble is seen in the upper part of it (Fig. 1-3). Marked gastrocoloptosis and redundancy of the left

flexure were noted in addition. Without any special treatment and notwithstanding her advanced age, patient has been getting along perfectly well up to the present time.

It is not important to discuss the symptomatology of gastric diverticula at any great length. The clinical symptoms are always as inconclusive as they have been in the case under discussion and diagnosis has to be made in all instances by roentgen examination. Credit of the discovery of gastric diverticula as a pathologic entity has been given to Fournier in 1774;<sup>19</sup> the first report is said to have been made by Helmont in 1804.<sup>3</sup> These two statements are explicitly refuted as erroneous in the exhaustive study of Martin<sup>12</sup> who credits Thomas Baillie with the description of the first authentic case in 1793. G. E. Brown in 1916 is said to have been the first one to demonstrate a gastric diverticulum before operation.<sup>12,19</sup> Thereupon, the number of cases multiplied, by far the most of the reported cases being based on characteristic findings when routine roentgen examination was done for a



FIG. 1. Diverticulum at the lesser curvature of the stomach near the cardia. Roentgenogram taken after one swallow of barium.



FIG. 2. Stomach filled with one glass of barium; patient is in reclining posteroanterior position.

gastrointestinal disorder of some kind. Many diverticula do not cause any symptoms<sup>4</sup> and are found incidentally or at autopsy. In other cases, ambiguous symptoms of different nature and varying degree are complained of, not a single one of which can be called pathognomonic. When roentgenological investigation is done, the finding of a gastric diverticulum comes to the examiner as a surprise in the overwhelming majority of cases, if not in all.

Akerlund in 1923 deserves credit for having written the first classical monograph dealing with roentgen diagnosis of gastric diverticula.<sup>14</sup> Since then, the diagnostic technique has not essentially changed.<sup>19,21,26</sup> All authors agree that there is no standard technique for visualization of gastric diverticula; gradual filling of the stomach, the use of different positions and angles, and—not the least—"diverticulum consciousness" of the examiner are of the greatest importance in their detection. Confusion with diaphragmatic hernia or ulcer crater<sup>12</sup> can be avoided by skillful maneuvers during examination.

Gastroscope may be of some diagnostic help and is mentioned as such in recent literature.<sup>16,19,22,23,24,25,29</sup> Schindler was able to detect three diverticular openings in 1,000 cases gastroscopied. Tracey<sup>29</sup> is doubtful about the value of this procedure in the diagnosis of gastric diverticula, and he explicitly warns against the possibility of per-

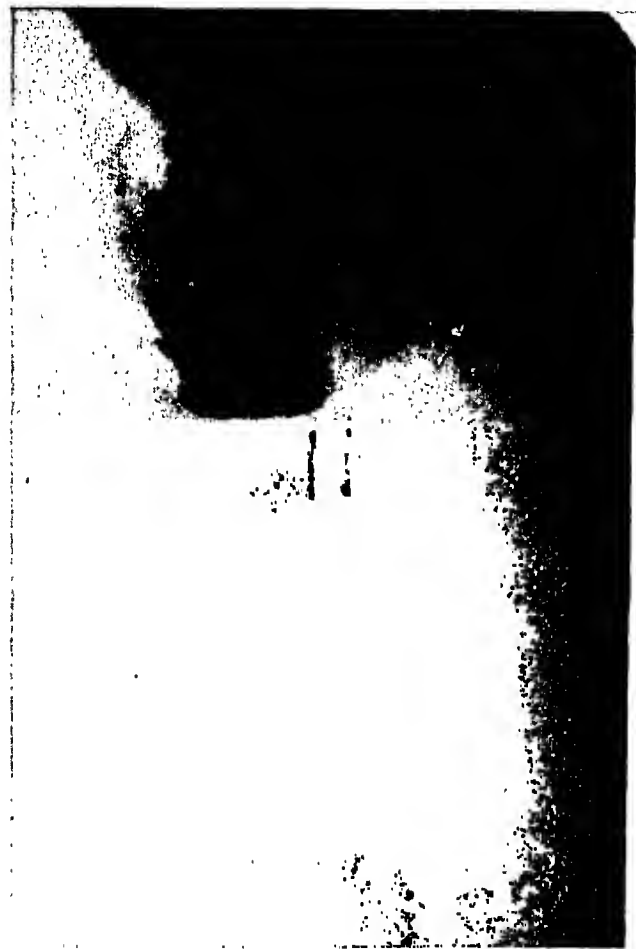


FIG. 3. Residue in diverticulum thirteen hours after barium meal; patient is upright in postero-anterior position.

forating a diverticulum with a wide opening in the cardiac region which is a rather inaccessible area for the gastroscope. He recommends gastroscopy in such cases only "if a capable surgeon should be within call in case of such a catastrophe." I feel that the danger of perforation in the presence of a diverticulum should not be overrated; however, the detection of a diverticular opening with the gastroscope is extremely difficult as everyone knows who does gastroscopy,

and, besides, meticulous roentgen examination of the stomach is such an excellent means of diagnosing gastric diverticula that gastroscopy is not necessary for that purpose.

The possibility of certain clinical complications has been mentioned in the literature: severe hemorrhage,<sup>28</sup> carcinomatous or sarcomatous degeneration in the walls of the diverticular sac,<sup>6,13,14</sup> and myomata.<sup>7,8,11,18</sup> All these complications are so extremely rare that they have none but academic interest.

Regarding treatment, a very different attitude is recommended by the different authors. Most of them agree that medical management is sufficient.<sup>4,20,29</sup> Some writers recommend the use of postural drainage in diverticula near the cardia.<sup>5,20,21,29</sup> Others advise surgery but only in diverticula of the distal two-thirds and if clinical symptoms or evidence of traction are present.<sup>3,21</sup> Whereas surgery in gastric diverticula near the cardia was denoted in 1926 as "an impracticable and usually impossible procedure,"<sup>9,10</sup> it is recommended quite recently in carefully selected cases under certain well defined indications.<sup>29</sup> Another author repudiates medical management of gastric diverticula as unsatisfactory and advises surgery in all cases without exception if diagnosis is certain.<sup>19</sup> There are certainly very few who would be inclined to follow such a radical advice in a condition which is usually harmless and nothing more than a roentgenological curiosity in the overwhelming majority of instances.

#### SUMMARY

A case of asymptomatic gastric diverticulum near the cardia in a woman, aged seventy-one, is presented and certain points of this rare condition are briefly discussed: classification, localization, symptomatology, diagnosis, complications and treatment.

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# THE VALUE OF VENOGRAPHY IN VARICOSE VEINS WITH REPORT OF THREE CASES

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VENOGRAPHY is receiving more and more recognition as an aid in the diagnosis and treatment of vascular diseases of the lower extremities. Until recently most of the investigators have concerned themselves with studies of thrombophlebitis and the associated problem of pulmonary embolism.<sup>5,17,22,23</sup> Its use in the study of arteriovenous fistula<sup>21</sup> and venospasm<sup>4,12</sup> has widened its field of application. It is the purpose of this paper to show the value of venographic studies in selected cases of varicose veins.

Varicose veins are the most common disorder of the venous circulation of the lower extremity. It has been estimated that about 10 per cent of young healthy adults suffer from superficial varicosities.<sup>3</sup> Ligation, excision or injection can be expected to produce results in most cases where such treatment is indicated. The applicability of any one or a combination of these methods will vary with the individual case. The obliteration of the superficial channels is carried out with the supposition that the deep veins are patent and will adequately handle all the venous return.

Barrow<sup>2</sup> has made a comprehensive survey of the physiology associated with varicose veins. We are in agreement with him in that practically all cases of asymptomatic superficial varicosities show normal deep and communicating veins while incompetency of the deep and/or communicating veins is usually present in patients with severe symptoms. It has been pointed out that the severe symptoms and disabling complications associated with varicose veins

are due to capillary hypertension and that a permanent cure can only be expected when the physiologic abnormalities have been corrected or compensated.<sup>2</sup> The frequency and importance of incompetent communicating veins in lower extremity varicosities is still an unsettled question.<sup>2,7,9,10,14</sup> Barrow reports that 86 per cent of the patients with superficial varicosities and incompetent communicating veins have a history of varicose ulcerations and that about 5 per cent of the patients with edema show obstruction to the deep circulation as demonstrated by the Perthes test.<sup>20</sup>

A careful physical examination with application of the Perthes and bandage<sup>9</sup> tests to determine the patency or occlusion of the deep veins and the Trendelenburg<sup>18</sup> and comparative tourniquet<sup>10</sup> tests to determine the competence or incompetence of the long saphenous and communicating veins will provide adequate information for a plan of successful treatment in a great percentage of cases.

The correct treatment of this condition necessitates a consideration of unfavorable postoperative sequelae and recurrence of varices following treatment. Operative and postoperative difficulties and hazards have been described by others<sup>1,6,19</sup> and will not be included in this paper. The recurrence of varices fall into two distinct groups: first, recurrence due to errors in technique or failure to observe certain precautions; second, in instances where the varicosities are associated with deep venous obstruction or marked stasis of the deep circulation.

Failures of high saphenous ligation, with

or without a retrograde injection of a sclerosing agent, are usually due to a lack of knowledge of the normal variations at the fossa ovalis.<sup>6,9,16</sup> Cases which Glasser has operated upon again show a patent medial or lateral superficial femoral vein. He reports no recurrences due to failure of ligation of the higher tributaries.

In instances of deep venous obstruction or marked stasis of the deep circulation, the superficial varicosities are compensatory and their obliteration will be followed by recurrence. This small but important group of cases should be identified by venographic studies and unnecessary or improper operative interference prevented. Clinically, all such patients will have severe symptoms of fatigue, pain on walking or standing and edema. The Perthes test and bandage test may show obstruction to the deep venous return. However, two most important facts must not be overlooked. First, there may be an almost complete stasis of the deep veins with compensatory varicosities of the superficial circulation. In such cases the patency tests will indicate an adequate circulation. Second, patency tests for the deep circulation may be misleading in that group of cases where the obstruction exists at or above the middle of the thigh.

A 35 per cent solution of diodrast is the most commonly used contrast medium. The possibility of serious sequelae following the use of this drug<sup>8,13,15</sup> necessitates a careful interrogation of each patient for a history of allergic manifestations and the application of a sensitivity test. Three instances of thrombosis of the deep veins of the leg have occurred following venography with 50 per cent diodrast. One of these was reported by Homans<sup>8</sup> and 2 additional cases were mentioned in an article by Scupham, de Takats, Van Dellen and Marcus.<sup>15</sup>

The following case reports are presented to illustrate the importance of venographic studies in selected cases of superficial varicosities.

#### REPORT OF CASES

**CASE I** (Fig. 1 and 2). A white male, aged forty-two, was admitted to an Army general



FIG. 1. Case I. Marked dilatation and stasis of the posterior tibial veins with numerous varicosities of the long saphenous vein.

hospital complaining of severe varicosities of the left leg with marked weakness and slight swelling of that extremity. The patient gave a history of a severe contusion to the lateral aspect of the left thigh in 1918 but except for this the history was entirely negative until 1922. In the latter year the patient noticed weakness of the left leg, pain on walking or standing and varicose veins of the left leg and thigh. His symptoms became progressively worse and a roentgen examination in 1930 was negative except for myositis ossificans at the site of the



FIG. 2. Case 1. Opaque medium pooled in tibial veins even though the leg was elevated between exposures of Figures 1 and 2.

previous injury. Since entering active duty on November 6, 1942, the symptoms have increased in severity and on several occasions weakness and dizziness have caused him to lose his balance and fall to the ground. Physical examination revealed a blood pressure of 104/70 and extensive varicosities of the long and short saphenous veins. The Perthes test indicated a patent deep circulation. The Trendelenburg and comparative tourniquet tests revealed in-

competence of the long saphenous and communicating veins. The symptoms were sufficiently severe to warrant venographic studies, which were done on July 12, 1943.

*Comment.* The venogram of the left lower extremity revealed marked stasis and dilatation of the tibial veins (Fig. 1). One segment of the posterior tibial vein measured 18 mm. in diameter. The proximal portions of the tibial veins were not well outlined due to the pooling of the opaque medium in the distal portions of the veins. Several incompetent communicating veins permitted visualization of the long saphenous vein and demonstrated its varicosities. The contrast medium passed from the long saphenous vein into the popliteal vein via the short saphenous vein. The long saphenous vein was not visualized above the level of the knee. The superficial femoral vein was slightly dilated. Serial roentgenograms showed emptying of the superficial system but the diodrast remained pooled in the distal portions of the tibial veins even though the leg was elevated to permit changing the cassette for the second exposure (Fig. 2). The conclusion reached was that the dilatation and stasis of the deep veins of the left leg were probably responsible for the development of the superficial varicosities and that obliteration of the varices was contraindicated. The symptoms of orthostatic collapse exhibited by this patient were considered to be secondary to the pooling of the blood in the left lower extremity. It was felt that operation would produce an aggravation of symptoms, probably permanent, in addition to provoking a recurrence of the varicosities. Local injections of sclerosing agents are definitely contraindicated because of the great possibility of producing a thrombosis in the tibial veins. If venous stasis is a prominent feature in the development of phlebothrombosis<sup>11,24</sup> then this patient is an excellent candidate for such an occurrence and any findings indicative of the onset of such a condition should be immediately followed by ligation of the femoral vein.

CASE II (Fig. 3 and 4). A white male, aged thirty, was admitted to an Army general hospital for study and surgical treatment of a large varicosity of the right thigh, present since childhood. This patient gave a negative history up to four years ago since which time he has had a moderate but persistent dull ache in the right thigh, aggravated by excessive walking or running. There has been no demonstrable edema of the ankle or leg at any time. The patient has had no operations and there has been no history of trauma. Physical examination revealed a hemispherical, protruding varicosity at the junction of the proximal and middle thirds of the anteromedial aspect of the right thigh. This varicosity measured 2 cm. in diameter and was apparently a part of the long saphenous vein which was palpable along its entire length. Extending upward from the varicosity there was a large, superficial vein which coursed medially across the abdomen at the level of the symphysis pubis and was then directed caudally to enter the deeper tissues of the left thigh just below the inguinal ligament. Patency tests indicated an adequate deep circulation and the Trendelenburg test indicated an incompetent communicating vein at the site of the varicosity. Venograms were made on April 26, 1943.



FIG. 3. Case II. There is complete atresia of the right external iliac vein. The anomalous long saphenous vein permits the venous return from the right lower extremity to pass through the left external iliac vein.

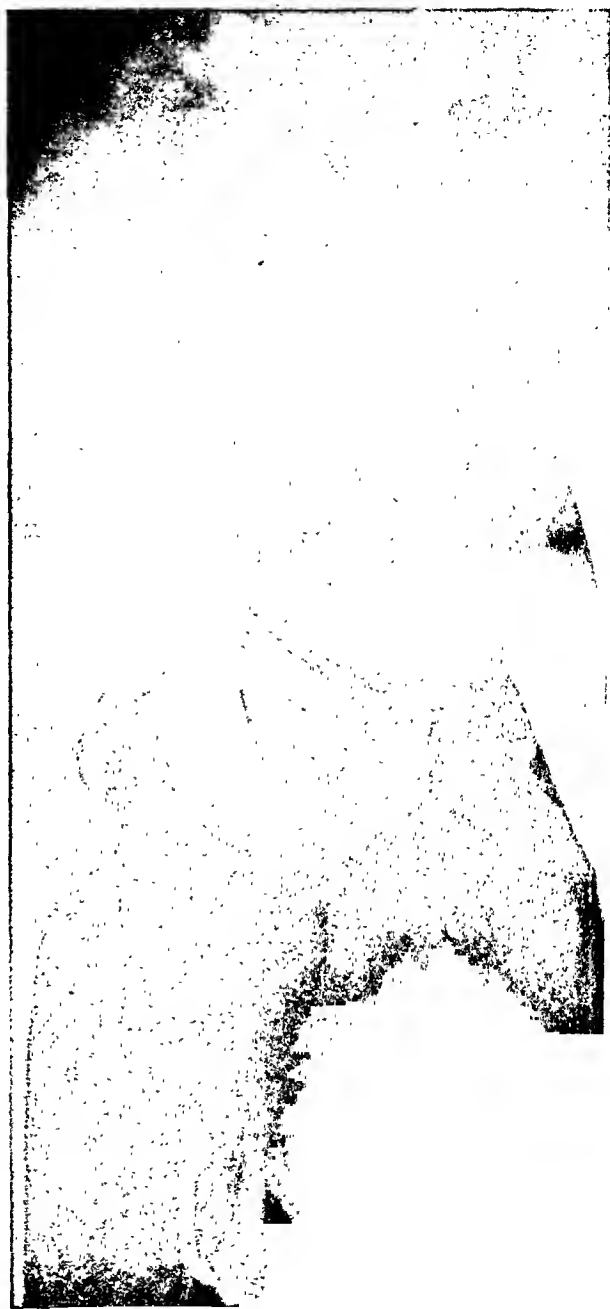


FIG. 4. Case II. Compression of the anomalous saphenous vein forces some of the opaque medium through the right superficial circumflex iliac vein.

*Comment.* The venograms did not outline the superficial femoral vein beyond the level of the lesser trochanter of the right femur. The long saphenous vein was well outlined up to the varicosity where there were several large communicating veins between the superficial and deep venous systems. The long saphenous vein, taking an anomalous course, was directed medially to



FIG. 5. Case III. Complete block of the left superficial femoral vein is seen near the top of the roentgenogram.

pass superficially over the abdomen just above the symphysis pubis. All of the opaque medium from the right lower extremity was carried through the latter channel to empty directly into the left femoral vein and then passed through the left external iliac vein. A small amount of opaque medium was seen in an irregular and completely obstructed right external iliac vein. Another venogram was made with the diodrast injected into the long

saphenous vein at about the mid-thigh. During the latter injection the anomalous long saphenous vein was compressed as it passed over the abdomen and this caused some of the opaque medium to pass through the right superficial iliac circumflex vein but the right external iliac vein was not visualized. Thus, for the second time, the patency of the right external iliac vein could not be demonstrated. The completely negative and long-standing history led to the conclusion that all the findings were on the basis of congenital anomaly. The diagnosis was congenital atresia, right external iliac vein, with an anomalous long saphenous vein carrying most of the venous return from the right lower extremity across the abdomen to pass through the left external iliac vein. On the basis of the venographic studies it was felt that operative interfer-



FIG. 6. Case III. The long saphenous vein is the only venous channel visualized in the upper two-thirds of the left thigh.

ence would produce a venous stasis and result in an aggravation of symptoms that in all probability would be permanent.

CASE 111 (Fig. 5 and 6). A white male, aged forty-six, was admitted to an Army general hospital because of slight varicosities of both legs and edema of the left ankle. This patient gave a history of an appendectomy in November, 1933, and following the operation he developed a severe thrombophlebitis in the deep veins of the left thigh. The postoperative convalescence was further complicated by pulmonary embolism on three separate occasions. Bilateral superficial varicosities soon developed and have persisted. The patient has had pain and cramping in both legs on walking or running. Physical examination revealed moderate superficial varicosities in both lower extremities with slight pitting edema of the left ankle and leg. The Perthes test indicated a patent deep venous circulation in both lower extremities. The Trendelenburg test indicated a bilateral incompetence of the long saphenous veins and incompetence of the communicating veins on the left. Bilateral venograms were made on January 2, 1943.

*Comment.* The venogram of the right lower extremity showed a normal deep venous circulation and several small varicosities of the long saphenous vein below the knee. The venogram of the left lower extremity revealed a few varicosities of the long saphenous vein. The deep venous system was entirely normal up to the junction of the middle and lower thirds of the thigh at which point the patency of the superficial femoral vein was abruptly terminated. There were numerous anastomoses between the superficial and deep venous channels in the lower half of the thigh. The correlation of the history and the roentgen findings resulted in a diagnosis of thrombophlebitis, superficial femoral vein, left, healed, producing a complete obstruction of this vein. In the upper two-thirds of the left thigh, the long saphenous vein was the only venous channel visualized and the conclusion reached was that this patient's symptoms were on the basis of venous stasis and that ligation and injection of the long saphenous vein for control of the vari-

cosities was contraindicated. Obviously, such operative interference would have produced an aggravation of symptoms, probably permanent in character.

The technique of venography is the same as that reported in a previous paper.<sup>12</sup> No untoward reactions have occurred.

#### SUMMARY AND CONCLUSIONS

Superficial varicosities are compensatory in obstruction or marked stasis of the deep veins. The positive evidence of venographic studies will defer surgical interference that might result in a permanent aggravation of symptoms in addition to a recurrence of the varicosities.

Considerable deep venous pathology may exist even though the patency tests indicate an adequate circulation.

The indications for venographic studies in cases of superficial varicosities are: (1) patients with a history of thrombosis or thrombophlebitis; (2) patients having severe symptoms of fatigue, pain on walking or standing, edema, or symptoms of orthostatic collapse, and (3) those few instances where anomaly of major channels is suspected.

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## RENAL DYSTOPIA DUE TO INTRA-ABDOMINAL MASSES

WITH A REVIEW OF THE LITERATURE AND REPORT OF FIVE CASES

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**D**ISPLACEMENT of the kidney by intrarenal tumors or by extrarenal retroperitoneal masses is well known. Similar dislocation of the kidney by intra-abdominal masses is apparently not so well known. It is the purpose of this paper to emphasize the latter possibility and to call attention to intra-abdominal masses in a discussion of the differential diagnosis of renal dystopia.

### REVIEW OF THE LITERATURE

In 1895, Dreyzehner<sup>1</sup> described a case of a pancreatic cyst which caused a rotation of one kidney; this was proved at operation. The author also reported that he had found 59 cases of pancreatic cysts in the previous literature; none of these, as far as could be ascertained, described any kidney displacement.

Bachrach and Hitzenberger<sup>1</sup> in 1930 presented the first case reported in the literature of kidney displacement caused by an enlarged spleen. They also described a case of hepatomegaly which caused similar displacement and reported other cases of splenomegaly, hepatomegaly, and an enlarged gallbladder which caused distortion of the kidney calices. It was their conclusion that extrarenal tumors (of the liver, spleen and gallbladder) could so affect the kidney that by pyelographic examination it would be impossible to differentiate them from intrarenal tumors. Haslinger<sup>11</sup> described a case of splenomegaly (etiology: Hodgkin's disease) where a pyelogram showed a downward displacement of the kidney; this was verified at operation. Another case, empyema of the gallbladder, also showed the right kidney to be pushed downwards by the tumor mass. Ecarius<sup>5</sup> reported a case of an enlarged spleen (due to

"angioendothelioma sarcomatosum et cavernosum") where the left kidney was displaced far to the right, across the midline. This was the first case to be reported which showed such marked displacement of the kidney by splenomegaly.

Haenisch<sup>10</sup> in 1931 presented 2 cases of renal displacement, one by an enlarged liver (of luetic etiology) and the other by an enormous gallbladder; in both of these cases, displacement was proved by operation.

Guyot, Villar and Traissac<sup>9</sup> in 1932 stressed the importance of using pyelography when dealing with abdominal tumors.

Friedl<sup>6</sup> in 1933 described a case of leukemia; here a greatly enlarged spleen caused displacement of the left kidney forward, downward and toward the right, past the midline.

Rapant and Bedrna<sup>17</sup> presented 2 cases of an enlarged spleen (one a splenic cyst and the other myelogenous leukemia) where there was medial and downward displacement of the left kidney. The authors stressed that such displacement, however, is not pathognomonic of splenic tumors because retroperitoneal masses will cause the same type of displacement.

In 1934, Mertz and Hamer,<sup>15</sup> reporting on the use of the lateral pyelogram in urologic diagnosis, said that with intraperitoneal tumors there seemed to be less tendency to vertical displacement or vertical rotation of the kidney. They presented a mixed series of cases one of which was an angioma of the liver; here pyelographic findings showed marked horizontal rotation of the right kidney. The other case was a sarcoma of the head of the pancreas which caused marked horizontal and moderate vertical rotation of the right kidney with definite anterior

displacement of the ureter and lower pole of the kidney. Gloor<sup>7</sup> presented the first cases reported in the literature of a splenic tumor causing kidney displacement. He described two types of such displacement: (1) a vertical dislocation caused by pressure of an enlarged spleen on a floating kidney, and (2) horizontal displacement toward the midline caused by formation of intimate adhesions between the capsules of the kidney and spleen.

Bigliardi<sup>2</sup> in 1935 discussed the use of intravenous urography in the differential diagnosis of abdominal tumors and concluded that such examinations should not be exclusively reserved for urologists but rather should be applied also to the localization of abdominal tumors.

In 1936, Shambaugh<sup>19</sup> at the Peter Bent Brigham Hospital, Boston, reviewed a series of 24 cases where the urologist was called in consultation to assist in determining the location of abdominal masses. Of these cases only one showed kidney displacement due to an enlarged spleen. In conclusion, the author stated his opinion that enlargement of the spleen, even when massive, almost never disturbed the position of the left kidney. He also stressed the point that a congenital malformation of the kidney may be confused with a true displacement.

Hyman and Wilhelm<sup>12</sup> in 1938, reporting on the differential diagnosis of renal and suprarenal tumors, presented a case of liver cirrhosis with marked splenic enlargement where a retrograde pyelogram revealed downward and mesial displacement of the left kidney. They concluded that tumors arising in the suprarenal region, when they attain a large size, dislocate the kidney but do not usually distort or obliterate the upper calices.

Wyller<sup>22</sup> described a number of extrarenal tumors among which was a case of splenomegaly (etiology: polycythemia); at operation this enlarged spleen was shown to have displaced the kidney. He also presented a case of hepatomegaly in which the liver did not displace the kidney and he said that in

his experience he had never seen kidney displacement associated with any gallbladder condition.

In 1939 at the Mayo Clinic, after reviewing a large series of urograms made in cases of intra-abdominal tumors, Schulte and Emmett<sup>18</sup> concluded that intra-abdominal tumors will not regularly displace the kidney or ureter but that a lesion of any abdominal organ *may* displace the kidney. Among their cases, they presented (1) a case of a cyst attached to the left lobe of the liver which resulted in downward displacement and rotation of the left kidney, proved by excretory urogram; (2) a case of hydrops of the gallbladder which produced a downward displacement of the right kidney, proved by retrograde pyelography, and (3) a large spleen which caused downward displacement and rotation of the left kidney, proved by retrograde pyelography. Weyrauch,<sup>21</sup> in discussing the use of the lateral pyelogram in a determination of the significance of renal torsion (in the diagnosis of retroperitoneal tumors) presented 3 cases of intraperitoneal masses, one of splenomegaly with displacement of the left kidney slightly medially, another of an epidermoid cyst of the spleen with displacement of the left kidney markedly downward and medially, and one of an enlarged liver (metastatic carcinoma) with displacement of the kidney also downward and medially. He concluded that splenomegaly and hepatomegaly may produce any type of renal torsion and result in a downward and medial displacement of the kidney. He also stated that in order to produce renal torsion, an intraperitoneal mass must be of considerable size and solidity and must project into the renal fossa.

Kretschmer<sup>13</sup> reported a case of subphrenic abscess with displacement of kidney and liver downward and another case of a pancreatic cyst which caused downward displacement of the right kidney with also displacement of the right ureter.

Kummer<sup>14</sup> also described a case of a cyst of the pancreas, proved at operation, and another case of splenic enlargement (etiol-

ogy: hemolytic icterus) both of which caused kidney displacement.

In 1940 Muschat and Edeiken<sup>16</sup> made a study of renal displacement and presented cases of splenomegaly, splenic infarction, pancreatic cyst and subdiaphragmatic cyst which caused displacement of the kidney. From their studies they concluded that the liver would *not* cause renal dystopia, and

that in most cases of kidney displacement caused by intra-abdominal masses one hardly ever finds abnormal microscopic findings in the urine. Weiss<sup>20</sup> presented 5 cases in which an enlarged spleen caused either displacement of the kidney or compression deformity of the kidney calices. He commented that the latter effect of splenomegaly is more common than has

TABLE I

	Spleno- megaly	Hepato- megaly	Spleno- megaly and Hepato- megaly	Pancre- atic Disease	Miscellaneous Mesenteric tumor Hydrops of gallbladder Cyst of gallbladder Mass of unknown etiology
Kidney displacement proved by..... { a. pyelography and operation.. b. flat plate.....	1 1	1	1	1	
No displacement shown by..... { a. pyelography... b. operation..... c. flat plate.....	0 5 2	6 2	3 1	3 3	3
No. of cases.....	9	9	5	7	3
Cases with <i>no</i> pyelography, no operation and no flat plate.....	10	1	12		1
No. of cases.....	10	1	12		1
Total Cases.....	19	10	17	7	4

presented cases of hepatomegaly, carcinoma of the liver and hydatid cyst to prove this.

Guardabassi<sup>8</sup> described a number of cases among which was a splenic cyst (echinococcus), a pancreatic tumor, and an enlarged liver (carcinoma), all of which caused kidney displacement.

In 1941 Cremer<sup>3</sup> presented, among a group of cases, 2 of renal distortion caused by splenomegaly. He concluded that displacement of the kidney or ureters or distortion of the calices cannot by themselves help differentiate between retroperitoneal and intra-abdominal tumors. He stressed the advisability of roentgen examination of the gastrointestinal tract as well as retrograde pyelography. He also pointed out

been believed, but that many more cases will have to be studied in order to establish just how often such distortion occurs.

REPORT OF CASES

At Harper Hospital in the last four and one-half years there have been 57 cases of splenomegaly, hepatomegaly, pancreatic tumors or miscellaneous intra-abdominal masses which might have caused displacement of the kidney. Of the total only 34 had either pyelography, a flat plate of the abdomen or an operation done to see if there was such displacement. Of this latter number, 5 cases, or 14 per cent, showed renal dystopia (Table I).

CASE I. A forty-three year old colored, married female whose only complaint was "pain in



FIG. 1. Case 1. A retrograde pyelogram showing marked displacement of the left kidney across the midline to the right.

the left side" of three weeks' duration. Physical examination revealed the presence of a large hard, non-tender mass about 6 by 5 inches in size in the left upper quadrant. The essential laboratory findings were: hemoglobin, 42 per cent; erythrocytes, 2.78 million; leukocytes, 5,300 and Kahn 3+ (repeat Kahn, "doubtful"). A gastrointestinal series showed no roentgen evidence of an intrinsic upper gastrointestinal lesion. There was marked displacement of the stomach and upper small intestine on the right by the large left tumor mass. Retrograde pyelography showed the left kidney to be pushed markedly to the right toward the midline (Fig. 1 and 2). On the basis of these findings the clinical impression by the urologists was a retroperitoneal sarcoma, probably inoperable; the internists believed the mass to be an enlarged spleen. A laparotomy revealed the presence of a very large spleen; this was attached by many adhesions to the left kidney

capsule and after removing the spleen the kidney was restored to its normal position automatically. Pathological examination of the spleen showed "an old fibrosis and congestion with organized areas of necrosis due to previous thrombosis of the splenic vein." The patient made an uneventful recovery following operation.

CASE II. A female, white, married, aged fifty-one, whose chief complaint was "severe pain in the left side" of one week's duration. The pain was so severe that it doubled her up and she could not get her breath. Physical examination revealed a visible mass about the size of a grapefruit in the left upper quadrant; this was tender to palpation and seemed to be more anterior than posterior. Essential laboratory findings: hemoglobin, 90 per cent; erythrocytes, 4.90 million; leukocytes, 7,400, Kahn reaction negative. A retrograde pyelogram showed some lateral displacement of the upper portion of the left kidney.

Clinical impression was a definite retroperitoneal mass. Therefore, an exploratory operation of the left kidney was done; the kidney appeared normal and there were a few hard glands



FIG. 2. Case 1. Roentgenogram from a gastrointestinal series showing the marked displacement of the stomach and upper small intestine on the right by the large left tumor mass.

lying between the kidney and the vertebral column. The large mass previously reported was definitely in the peritoneal cavity. Following this operation the patient developed aspiration pneumonia and ran a rather stormy course for about a week. Two weeks after the pneumonia cleared up an exploratory laparotomy was done; the stomach was markedly displaced to the right side. Further examination revealed a large tumor mass which extended well up into the left dome of the diaphragm, displacing the liver and stomach to the right. The tumor extended down into the right side well below the liver level; it was firm, smooth in outline and appeared to rise from the pancreatic area. The spleen was displaced but was of normal size and shape. Final diagnosis was a pancreatic tumor (Fig. 3).

CASE III. A female, white, married, aged fifty-eight, whose chief complaint was "a mass with pain in the left upper part of the abdomen" associated with progressive weakness and ease of fatigue. Physical examination showed palpable cervical and axillary glands. The spleen was enlarged, a hand's breadth below the umbilicus. Essential laboratory findings: erythro-



FIG. 3. Case II. A retrograde pyelogram showing lateral displacement of the upper portion of the left kidney.



FIG. 4. Case III. A flat roentgenogram of the abdomen showing the left kidney displaced downward.

cytes, 3.20 million; leukocytes, 91,000, lymphocytes, 94 per cent; Kahn reaction negative. Roentgenographic examination of the urinary tract showed displacement of the left kidney downward. Final diagnosis was subacute lymphatic leukemia (Fig. 4).

CASE IV. A white, single Italian male, aged thirty-six, whose chief complaint was "swelling of the abdomen" of two weeks' duration. This was associated with some swelling of his ankles but he had no dyspnea, orthopnea or precordial pain. The only item of interest in his past history was an acute attack of "rheumatism" at the age of eight. Physical examination revealed a markedly distended abdomen with a palpable fluid wave and shifting dullness. The liver edge was down about four to five fingerbreadths but the spleen was not palpable because of the marked distention. Essential laboratory findings were: hemoglobin, 82 per cent; erythrocytes, 4.50 million; leukocytes, 5,350; icteric index of 13, prothrombin time of 60 per cent and Kahn reaction negative. A flat plate of the abdomen showed enlargement of the spleen with displacement of the left kidney toward the midline. Final diagnosis was Banti's syndrome (Fig. 5).

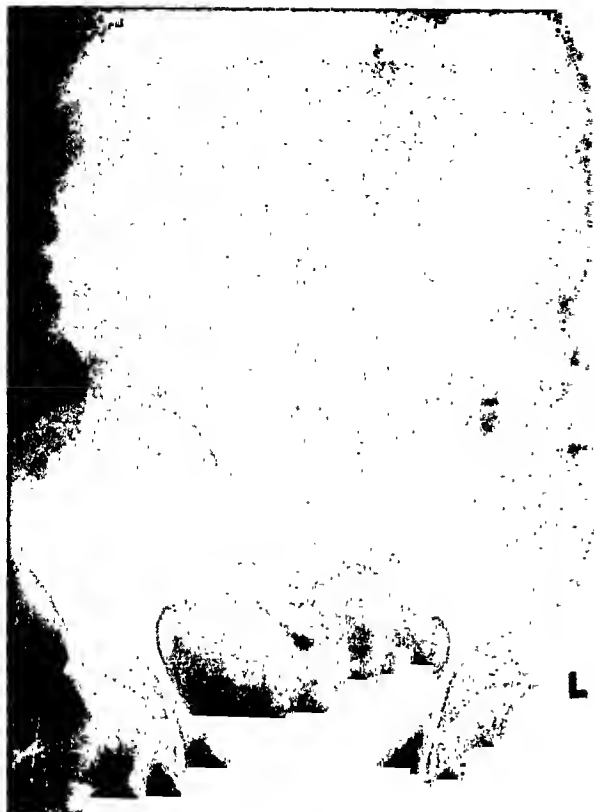


FIG. 5. Case IV. A flat roentgenogram of the abdomen showing displacement of the left kidney toward the midline.

CASE V. A white, married male, aged fifty-three, whose chief complaints were "weight loss" and gaseous eructations of three months' duration and epigastric pain of six weeks' duration prior to admission. The patient said he had malaria in 1906 and typhoid fever in 1907, both without apparent complications. Physical examination revealed a fairly elderly male of dark complexion, appearing chronically ill but who was alert. The liver extended about six to seven fingerbreadths below the right costal border and the edge was sharp, hard and non-nodular. Spleen was palpable. Essential laboratory findings were: hemoglobin, 71 per cent; erythrocytes, 3.80 million, and leukocytes 6,900.

A flat plate of the abdomen gave roentgen evidence of a large mass which was "apparently an enormously enlarged liver." A laparoscopic examination was done which revealed "many strands and planes of rather well organized delicate adhesions partitioning the pneumoperitoneal space into many small pockets." Three months later an exploratory laparotomy was done and the liver was found to be "entirely involved with carcinoma which left no portion of

the liver normal." The spleen was also enlarged and the right kidney was displaced anteriorly and medialward. Final diagnosis was primary carcinoma of the liver; this was later also proved at autopsy (Fig. 6).



FIG. 6. Case v. An intravenous pyelogram showing the left kidney rotated on its axis.

#### COMMENT

A survey of the literature regarding renal dystopia seems to indicate that while displacement of the kidney by intra-abdominal masses is not common yet it can and does occur.

Although in the literature the individual authors express such varying opinions as splenic enlargement almost never disturbs the position of the left kidney (Shambaugh<sup>19</sup>), or kidney displacement is never seen associated with any gallbladder condition (Wyler<sup>22</sup>), or the liver does not cause renal dystopia (Muschat and Edeiken<sup>16</sup>), their colleagues have reported cases which disprove these statements.

The best explanation of the mechanical

displacement of the kidney by the spleen is that given by Gloor<sup>7</sup> who described such dystopia as caused by (1) pressure of the spleen on a floating kidney, thus dislocating the latter downward, or (2) adhesions between the capsules of the kidney and spleen causing horizontal displacement of the kid-

be determined. In the second case presented, because of the renal displacement as shown by retrograde pyelography, the clinical impression was a retroperitoneal mass; this was not borne out by operation which revealed instead an intra-abdominal mass arising from the pancreas.

TABLE II

	Physical Examination	Type of Roentgen Examination	Roentgen Findings	Diagnosis
Case I Mrs. E. J. (263456)	Mass in left upper quadrant extending from left costal region to midline and well down toward pelvis	Retrograde pyelogram	Displacement of the left kidney to the right	Splenic vein thrombus (etiology, syphilis) causing splenic infarction and splenomegaly
Case II Mrs. E. Y. (236538)	Mass in left upper quadrant, tender, size of a grapefruit	Retrograde pyelogram	Lateral displacement of the upper portion of the left kidney	Pancreatic tumor
Case III Mrs. C. S. (217193)	Large spleen, hand's breadth below the umbilicus, to level of crest of ilium	Flat plate of the abdomen	Left kidney displaced downward	Subacute lymphatic leukemia
Case IV Mr. R. P. (225282)	Liver down about 4 to 5 finger breadths. Spleen not palpable due to marked distention	Flat plate of the abdomen	Left kidney displaced toward the midline	Banti's syndrome
Case V Mr. C. F. (220823)	Liver down about 6 to 7 finger breadths; edge sharp, hard, non-nodular. Spleen palpable	Intravenous pyelogram	Rotation of the left kidney on its axis	Primary carcinoma of the liver

ney toward the midline. It is noteworthy that in the first case I presented the urologists believed the renal dystopia was definitely due to a retroperitoneal mass because a good explanation for such marked displacement by the spleen could not be found. If the surgeons had not insisted on an exploratory laparotomy, nothing would have been done for the patient and she probably would have continued on a downward course.

The possibility of an intra-abdominal mass is important to include in the differential diagnosis of renal dystopia in order that a more complete case evaluation can

#### CONCLUSIONS

Concerning renal displacement by intra-abdominal masses:

- (1) A review of the literature is given.
- (2) Five new cases are presented.
- (3) The importance of such masses in the differential diagnosis of renal dystopia is stressed.

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# THE EFFECTS OF REPEATED IRRADIATION OF THE GASTRIC REGION WITH SMALL DOSES OF ROENTGEN RAYS UPON THE STOMACH AND BLOOD OF DOGS

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IT IS known from previous investigations (Desjardins; Palmer and Templeton; Miescher; Ivy, Orndoff, Jacoby and Whitlow; Case and Boldyreff) that the roentgen irradiation of the stomach of experimental animals, including dogs, results in a depression or suppression of the gastric secretion, characterized by a lowering of the free and total acid, a reduced volume of secretion, and a decreased pepsin content of the gastric juice. No studies have been made so far as to the action of such a treatment upon the erythropoietic activity of the bone marrow and upon the blood through a possible effect upon the production of the so-called "intrinsic factor" of Castle.

The present communication relates the observations made on the blood and internal organs of dogs which were irradiated over the gastric region with small doses of roentgen rays over prolonged periods of time.

## EXPERIMENTAL PROCEDURE

Seven mongrel dogs weighing from 5.2 to 9.6 kg. at the start of the experiment were subjected to a series of roentgen irradiations over the gastroduodenal region. The rest of the abdomen was protected by lead sheeting. The treatments were given on five days of the week using each day a different filter in the order given below and reversing the portal weekly (anterior and posterior portals) so as to insure a uniform exposure of the entire viscus. The filters used were 1 mm., 2 mm., 3 mm. Al, 0.25 mm. Cu plus 0.5 mm. Al, and 0.5 mm. Cu plus 0.5 mm. Al. The fields measured 10 by 10 cm. The distance was 50 cm. The roentgen apparatus delivered 130 kv. (peak) and 5 ma. The stomach was filled before each irradiation

with a barium sulfate suspension to localize and distend this organ adequately and to increase the amount of secondary radiation. Series I consisting of 3 dogs received the treatment shown in Table I.

TABLE I

DOSAGE

(Series I)

5 consecutive weeks	15 r daily
4 consecutive weeks	30 r daily
2 consecutive weeks	60 r daily
1 week rest period	
5 consecutive weeks	60 r daily
1 week rest period	
1 week	60 r daily
1 week rest period	
1 week	60 r daily
1 week rest period	
1 week	120 r daily
1 week rest period	
1 week	120 r daily

A total of 4,875 r was given during twenty-five weeks. The dogs remained in good health and were sacrificed sixteen months after the start of the experiment by an intravenous injection of 30 cc. of a 4 per cent formaldehyde solution.

The other 4 dogs composing the second series received on each day 300 r for four successive weeks (total 6,000 r). After an initial gain of 2 to 2.5 kg. the dogs lost progressively in body weight until they reached approximately 50 per cent of their maximum weight toward the end of the experiment. One of the 4 dogs died acutely at the end of the eighth week following the aspiration of barium sulfate suspension into the lungs. The other 3 dogs of this series died nine, thirteen, and sixteen weeks, re-

spectively, after the start of the experiment as the result of a perforated gastric ulcer. The dogs were highly emaciated at this time and had an atrophic and epilated skin over the gastric region. There were ulcers of the skin present in 2 dogs.

#### HEMATIC DATA

Hematological studies were made on the dogs of the first series at intervals of two

TABLE II

HEMATIC CHANGES IN DOG IRRADIATED DURING 25 WEEKS WITH DOSES RANGING FROM 15 TO 120 r

Weeks	Hemoglobin	Erythrocytes	Leukocytes
0	14.2	6.15	11.7
2	15.4	6.46	9.2
4	14.9	6.88	11.5
6	15.6	7.05	11.0
10	17.2	7.45	10.6
14	11.4	5.34	14.3
18	11.4	4.96	11.2
28	17.2	8.31	11.9
30	14.5	8.32	10.5
34	15.6	6.46	7.7
50	14.2	5.51	9.5

weeks during the first two months and at intervals of one month thereafter. Blood examinations were performed on the dogs of the second series once every week throughout the entire experimental period.

Following an initial mild increase in the number of erythrocytes the dogs of the first series showed at the end of the twenty-fifth week a definite decrease amounting to 15 to 20 per cent of the original value. The hemoglobin and hematocrit values underwent similar fluctuations, whereas the number of leukocytes remained within normal limits. One month after the cessation of the roentgen treatments the number of erythrocytes had recovered and surpassed by approximately 20 per cent the original level where it remained for about two months before it dropped gradually back to pretreatment values. Table II shows the hematic changes in 1 dog.

The erythrocytes of the dogs of the sec-

ond series remained within normal limits during the first two to three months and then decreased in number to a moderate to marked degree, depending upon the length of the survival period. This numerical reduction of the erythrocytes was usually preceded by a mild to marked drop in their hemoglobin content which exceeded in degree that of the number of cells and reached in one instance more than 50 per cent of the original value giving a color index of below 1. The number of leukocytes fluctuated irregularly in the different animals. There were no appreciable changes present in 2 dogs; a considerable decrease in number associated with the appearance of immature cell forms was noted in a third dog, while a marked elevation of the number of leukocytes up to 55,000 was found in the fourth dog. The number of reticulocytes did not vary significantly during the first month of treatment. Table III presents the blood findings of 1 of these dogs.

TABLE III

HEMATIC REACTIONS IN DOG 356 IRRADIATED OVER THE GASTRIC REGION WITH 20 X 300 r

Days	Hemoglobin	Erythrocytes	Leukocytes	Reticulocytes
0	16.2	6.65	9.9	0.4
6	14.3	5.79	11.25	0.4
15	14.5	6.1	14.9	0.2
26	16.0	7.3	11.6	0.4
33	14.2	6.76	17.8	
40	12.0	6.26	17.2	
47	13.2	6.53	17.2	
54	12.9	6.81	21.6	
61	13.9	6.95	23.6	
68	13.1	6.01	39.4	
75	12.2	5.59	36.6	
82	10.1	4.65	36.3	
89	9.0	4.35	34.0	
96	7.8	3.45	55.4	
103	6.5	3.47	33.4	
113	Death from perforated gastric ulcer			

#### ANATOMIC DATA

The postmortem examination of the 3 dogs composing the first series did not reveal any abnormal significant gross changes of the internal organs. The dogs of the sec-

ond series revealed, on the other hand, a definitely thickened and edematous gastric and duodenal wall. There was a small opening in the gastric wall in the prepyloric region of the greater curvature in 3 dogs. The stomachs showed here shallow mucosal defects measuring about 2.5 to 4 cm. in diameter and having a central, narrow, cone-shaped crater penetrating the entire wall. The edges of the ulcers were sharply cut out. A coffee-ground colored mucus was attached to the surrounding edematous mucosa. The abdominal cavity contained a small amount of brownish turbid fluid. All other organs were normal with the exception of scattered pulmonary hemorrhages and the presence of white matter in the bronchi of the dog which died acutely after the aspiration of barium sulfate suspension into the lung.

The stomachs as well as most of the other internal organs (duodenum, colon, pancreas, liver, lung, aorta, heart, pulmonary artery, adrenals) of the dogs of the first series were histologically normal. The liver of 1 dog revealed, however, a considerable fatty degeneration of the liver cells associated with an appreciable increase of the periportal and intralobular connective tissue. Small groups of intact liver cells were found scattered along the connective tissue septa. The reticulum cells of the spleens contained in 2 dogs large amounts of an amorphous brown pigment. The bone marrow of the 3 dogs consisted of a loose fat tissue containing an irregular scattering of strands and nests of immature myeloid cells. The reticulum cells in the bone marrow of 1 dog were filled in part with a brown amorphous pigment.

The histological changes found in the organs of the dogs of the second series contrasted sharply with these relatively insignificant findings. The epidermis of the irradiated abdominal skin was in most places definitely atrophic, and showed some hyperplastic proliferative extensions in a few areas. The ulcerative epidermal defects were covered with a leukocytic, necrotic mass loosely attached to a fibrous and hya-

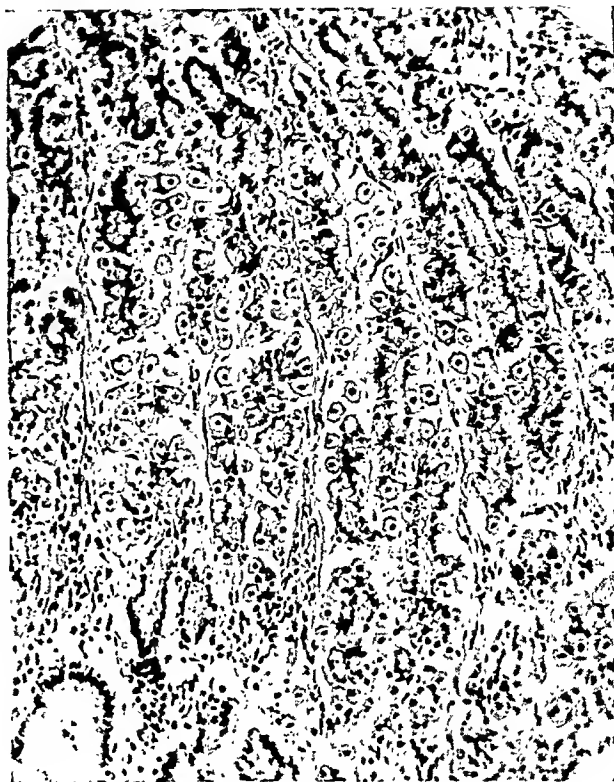


FIG. 1. Mucosa of the gastric fundus showing a degeneration and disappearance of the chief cells and a predominance of the parietal cells.

line subcutaneous tissue. The sweat and sebaceous glands and the hair follicle were definitely atrophic or had disappeared entirely, leaving small whirl-like scars. Numerous small follicular cysts lined by concentrically arranged layers of a flat epithelium were found in 1 dog. The cutaneous and subcutaneous vessels were often ectatic. Some of the arteries had swollen walls. The underlying muscle tissue of the abdominal wall showed focal waxy degenerations associated with a proliferation of the muscle cell nuclei and, in places, with calcification of the necrotic muscle cells.

*Stomach:* The mucosa of the cardinal portion was normal. The mucosa of the fundus was normal in one dog, and showed an extensive degeneration or loss of the chief cells, preservation of the parietal cells, and scattered focal necrosis of the superficial columnar cells in a second dog. The submucosa and muscularis were normal in these 2 dogs. Similar mucosal changes were present in the fundus region of a third dog, but they were accompanied by a fibrotic

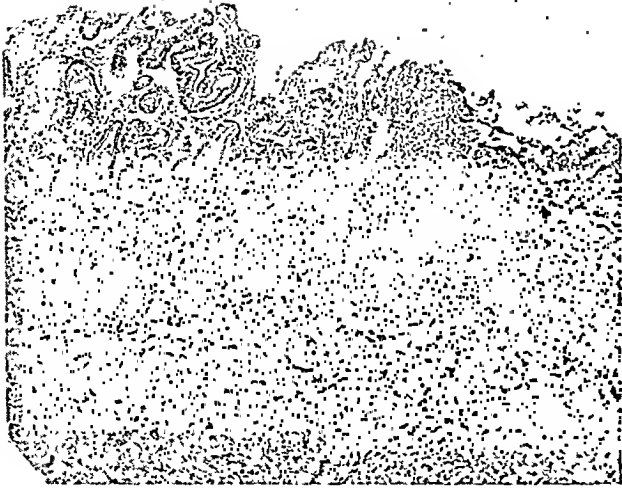


FIG. 2. Ulcer in the prepyloric region covered with a thick leukocytic exudate.

submucosa and hyaline degenerated muscularis which had in places a bluish cast suggesting a beginning calcification. In a fourth dog such lesions were combined with the presence of cystic glandular formations filled with a mucoïd material (Fig. 1). The submucosa was highly edematous. In the neighborhood of the ulcerative defects located in the prepyloric region of the fundus the submucosa was markedly swollen and in places hyaline. There was moreover a diffuse and moderate leukocytic infiltration present (Fig. 2). The walls of the vessels were swollen and homogeneous (Fig. 3). Necrotic and inflammatory changes extended into the muscularis and subserosa, in which the lymphatics and veins were highly dilated and sometimes lined by huge, distorted endothelial cells. In one area of the prepyloric region of 1 dog there was a complete disappearance of the epithelial elements in the mucosa leaving a collapsed connective tissue framework which covered an edematous congested submucosa containing vessels with swollen and hyaline walls. The mucosa of the pylorus exhibited an atrophic and, in places, cystic mucosa.

*Duodenum:* Superficial mucosal necrosis and occasional glandular cyst formation were observed in 2 dogs.

*Spleen:* Much amorphous brown pigment was noted in the reticulum cells.

*Kidney:* Some of the small arteries and arterioles of 2 dogs had swollen and edematous walls and a narrow subendothelial hyaline zone. In 1 of these 2 dogs there was an increase of the interstitial connective tissue which was infiltrated with lymphocytes and was transformed in places into a hyaline network. Numerous glomeruli had thickened hyaline capillary walls.

*Testes:* The spermatogenic epithelium in the testes of 3 dogs was markedly degenerated, leaving often only a single layer of Sertoli's cells or a mixture of Sertoli's cells with spermatogonia. Some tubules contained spermatid giant cells. The testes of the fourth dog were normal.

*Bone Marrow:* A dense myeloid bone marrow was present in 2 dogs, while a loose fat tissue containing a moderate admixture of myeloid tissue was found in the other 2 dogs.

*Liver:* The livers were edematous and hyperemic. There was a narrow subcapsular zone of necrosis of liver cells present in 1



FIG. 3. Albuminoid swelling and necrosis of the vascular walls in the subserosa beneath the ulcerative defects.

dog. The liver cells in the demarcation zone were small and hyperchromatic. Numerous brown or brownish-gray pigmented phagocytic cells were noted in the tissue around the central veins and in the periportal tissue.

*Aorta:* A small intimal coagulation necrosis was found in the descending aorta of 1 dog. The aorta of a second dog revealed a marked medial mucoid imbibition in one sector and an almost complete fibrosis and hyalinization of the media involving approximately one-half of the circumference in a second sector. There were a few foci of medial muscular degeneration in the aorta of a third dog.

The following organs were histologically normal: lung, heart, pancreas, adrenal, lymph nodes, small and large intestine, epididymis, bladder, and brain.

#### COMMENT

The hematic and organic reactions recorded indicate that a prolonged irradiation of the stomach with small doses of roentgen rays produces an anemia of the secondary type and not one of the pernicious variety, which would have resulted if the treatment given had interfered with the production of the "intrinsic factor" generated by the gastric mucosa, according to Castle. The absence of any significant anatomical lesions in the gastric mucosa of the dogs of Series I makes it unlikely that the actinic energy administered to the stomach elicited here any specific and permanent secretory damage, especially as the transitory anemic response reverted rapidly after the cessation of the treatment to a transient erythrocytotic reaction. The secondary anemia noted in the dogs of the second series during the latter part of the experimental period is evidently attributable to a continued loss of blood from the ulcerated gastric mucosa. The changes in the gastric mucosa of these animals were also responsible for the severe loss of weight sustained by them as the result of loss of appetite and associated digestive disturbances.

The chief cells of the gastric mucosa are, according to the observations made, definitely more sensitive to the action of the roentgen rays than any other cellular element of the gastric mucosa. The parietal cells appear to be particularly resistant, while the surface cells and glandular epithelium of the cardiac and pyloric regions occupy an intermediate position in this respect. The mucosal lesions recorded, such as glandular mucoid cysts, atrophy of epithelial cells with bizarre distortions and swelling, interglandular edema and fibrosis, submucosal edema, congestion, fibrosis, hyalinization, and leukocytic infiltration associated with vascular dilatation and arterial edema and hyalinization, are similar to those reported before by Warren, and Warren and Friedman; Delbet, Herrenschildt and Mocquot; Regaud, Nogier and Lacassagne, and others. They are fundamentally of the same type and origin as those which were seen by us in the intestinal mucosa of 13 dogs one to three weeks after the administration of 1,200 to 1,500 r over the abdomen for the production of a traumatic shock, as well as those elicited in the mucosa of the urinary bladder of 22 dogs by the administration of 1,200 r (Hueper, Fisher, Carvajal-Forero and Thompson).

The occurrence of hemangiectases and lymphangiectases in the submucosa which was lined by swollen, protruding endothelial cells confirms observations previously made by Dawson; Ivy, McCarthy and Orndoff; Kolodny, and Lazarus-Barlow. The hyalinizing and sclerosing arterial lesions present in the region and especially the floor of the gastric ulcers are similar in type and location to those noted in the ulcerated stomach of dogs subjected to histamine shock (Hueper and Ichniowski) as well as to those found in the small arteries of the thickened and inflamed renal capsules of dogs with cellophane perinephritis. These arterial changes are not the cause of the gastric ulcers and are not of specific actinic origin, but secondary to the necrotizing and sclerosing tissue changes caused

in the gastric wall by the roentgen rays (Engelstad; Schürch and Uehlinger).

While it is possible that the degenerative and sclerosing intimal and medial lesions seen in the descending aorta of 3 dogs of the second series may have an actinic genesis, the appearance of similar arterial and arteriolar changes in the kidneys of 2 dogs as well as the extensive atrophy of the spermatogenic epithelium of 3 dogs of this series makes it more likely that they are non-specific sequelae of metabolic disturbances elicited by the roentgen irradiation during the latter part of the experimental period.

#### SUMMARY

1. Roentgen rays given in doses of 15 to 120 r up to a total of 4,875 r within twenty-five weeks over the gastric region of dogs cause only minor anatomic changes in the gastric mucosa, and a transitory and moderate anemia of the secondary type which is followed by an erythrocytotic phase after the cessation of the actinic treatment.

2. Roentgen rays administered in doses of 300 r up to a total of 6,000 r within four weeks produce a marked loss in body weight, a moderate to severe secondary anemia, and perforating gastric ulcers at the end of this period.

3. There is no evidence that roentgen rays administered in the above manner have any injurious effect upon the production of the "intrinsic factor" of Castle.

4. The chief cells of the gastric mucosa are most sensitive to the action of the actinic energy, while the parietal cells appear to be most resistant.

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# SOME COMPARATIVE STUDIES IN THE ARRANGEMENT OF RADIATION BEAMS

## THREE IDENTICAL CIRCULAR BEAMS DISPOSED SYMMETRICALLY

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IN RECENT years considerable attention has been given to the total distributions of radiation that result from various combinations of a number of radiation beams,<sup>2,3,4,10</sup> and special methods have been devised for the detailed study of such distributions throughout the whole volume of irradiated tissues.<sup>5,7,8,9</sup> As a result of the investigations into these matters it has been shown that, if optimum and homogeneous conditions of dosage are to be achieved, it is essential that the positions and the directions of the individual beams be arranged by a very careful reference to the shape of the beams as expressed by their dose contours. In many cases this reference indicates that the beams should be directed not at the tumor itself but at some other point or points at a greater depth in the tissues,<sup>2,3,10</sup> a result which is contrary to customary radiotherapeutic practice.

This article describes an investigation into the effect of various factors upon the total radiation distribution due to three identical circular beams of radiation arranged symmetrically and inclined at a common angle to a basic plane. It is assumed that the same dose is delivered by each beam. An example of such an arrangement has been discussed by Lamerton and Mayneord<sup>3</sup> for three roentgen-ray beams but the present study is of a more general character. A number of beams are considered, each inclined at various angles to the basic plane and the effect of changing the spacing of the beam centers is examined in some detail. This investigation, which forms part of a general study of the combination of radiation beams, is principally concerned with the gamma-ray beams from radium

mass units but some cases of roentgen-ray beams have been considered also.

The use of a symmetrical three field technique in the irradiation of a breast has been commented on<sup>3</sup> and at Westminster Hospital such a technique has proved of value also in the roentgen-ray and gamma-ray irradiation of certain brain tumors, metastatic and other glandular masses, and in the treatment of lesions near or in the skin surface which also extend to a considerable depth.

### RADIATION BEAMS

The various beams considered are as follows:

1. Gamma-ray beam of Westminster Hospital 4 gm. radium unit.<sup>1</sup> Field 3.5 cm. diam: F.S.D. = 8.0 cm.
2. Gamma-ray beam of Radium Beam Therapy Research 5 gm. radium unit.<sup>12</sup> Field 5.0 cm. diam: F.S.D. = 8.3 cm.
3. Gamma-ray beam of Westminster Hospital 4 gm. radium unit.<sup>1</sup> Field 9.0 cm. diam: F.S.D. = 8.0 cm.
4. Roentgen-ray beam, 190 kv. Thoraeus filter. H.V.L. = 1.8 mm. Cu. Field 5.0 cm. diam: F.S.D. = 50 cm.
5. Roentgen-ray beam, 190 kv. Thoraeus filter. H.V.L. = 1.8 mm. Cu. Field 10.0 cm. diam: F.S.D. = 50 cm.

The dose contours of the gamma-ray beams have been published.<sup>1,12</sup> Those of the roentgen-ray beams are shown in Figure 1. The focus-skin distance of the Radium Beam Therapy Research 5 gm. unit (8.3 cm.) is little different from that of the Westminster Hospital 4 gm. unit (8.0 cm.) so that we may consider the former as a beam of area between the two areas of the Westminster Hospital unit but otherwise comparable.

It is assumed throughout that conditions of scatter and absorption, in the practical application of the beams to the patient, are such that the dose contours, which are measured in complete phantoms, are valid. In the case of the gamma-ray beams it is unlikely that any large errors will arise

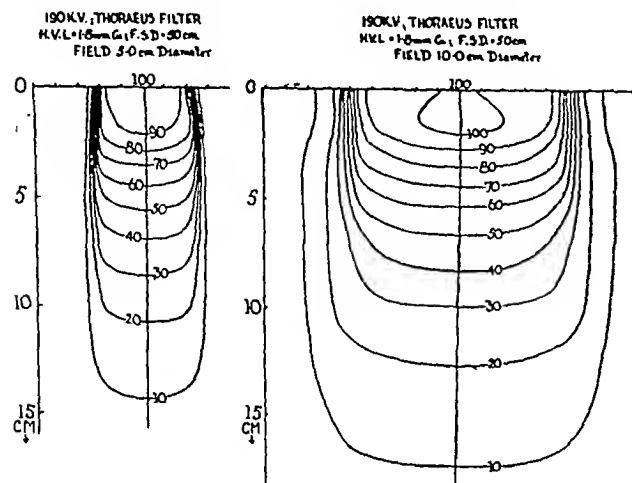
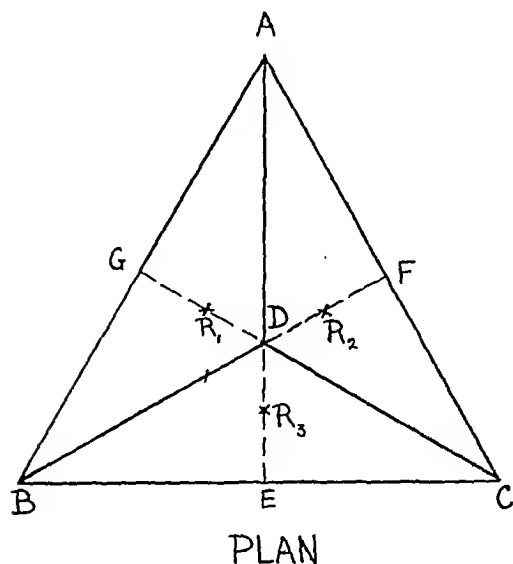


FIG. 1. Dose contours of roentgen-ray beams.

because of these factors, but for roentgen-ray beams it would be essential to add suitable scattering media (bolus bags, wax, etc.) to fill any gaps that may be produced through the arrangement of the beams.

#### DISPOSITION OF THE BEAMS

The symmetrical disposition of the three



fields may be illustrated generally as in Figure 2. In effect the surfaces of the fields are applied to the sides  $ABD$ ,  $ADC$  or  $BDC$  of a tetrahedron  $ABCD$  which is shown in plan. The central rays of each beam are directed through symmetrically disposed points  $R_1$ ,  $R_2$  and  $R_3$ . The tissues to be irradiated thus lie beneath the sides of the tetrahedron, the beams being directed through the tissues in directions such as  $R_2T$  shown in the section drawn through the plane  $BDF$  (Fig. 2).

For each of the beams described above, the dosage conditions and the factors which govern them, were examined for specific values of the angle  $\theta$  between any one of the sides of the tetrahedron and the basic plane. The values taken were  $15^\circ$ ,  $30^\circ$ ,  $60^\circ$  and  $90^\circ$ . When  $\theta = 90^\circ$  the fields are no longer applied to the sides of a tetrahedron but are symmetrically situated around a circle. The latter arrangement is typical of methods often used for the irradiation of a whole limb.

#### DISTRIBUTION OF DOSAGE IN THE PLANE OF ENTRY

It is of interest to examine how the distribution of dosage in the plane  $OR_1R_2R_3$  depends on the angle of slope  $\theta$  and the

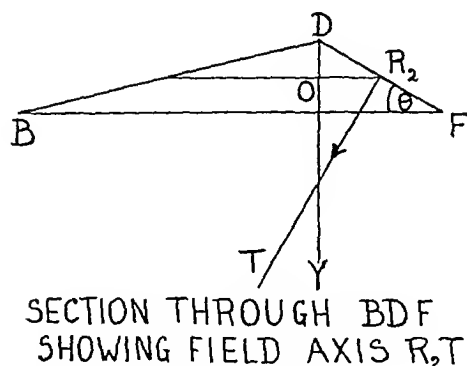


FIG. 2. Illustrating the geometrical features of the arrangement of three radiation beams.

radius of separation of the fields  $R_2O$ , especially with regard to the homogeneity of the distribution. The plane  $OR_1R_2R_3$  may be referred to as the "plane of entry" of the beams and for moderate values of  $\theta$  it would coincide approximately with the skin surface around which the fields are arranged. When  $\theta=90^\circ$  the plane of entry becomes the central plane of the tissues which are encompassed by the three fields and it carries the maximum dosage values of the irradiated volume.

A convenient measure of the degree of homogeneity of dosage in the plane of entry is the ratio of the total dose at the center point  $O$  to that at the points of entry  $R_1$ ,  $R_2$ , or  $R_3$ , of any of the beams. The latter we shall refer to as the "surface dose." The dose at  $R_1$ ,  $R_2$  and  $R_3$  is the same because of the symmetry of the arrangement and the "center dose" at  $O$  is made up of three equal parts, one part due to each beam. The greatest homogeneity exists in the plane of entry when the value of the ratio center dose to surface dose is unity; a more detailed examination of the total distribution in this plane shows that the dose at any other point is seldom greater than it is at  $R_1$ ,  $R_2$ ,  $R_3$ , and  $O$ .

The results obtained from the examination are shown graphically in Figure 3. The curves show how the ratio (expressed as a percentage) of the center dose and surface dose depends upon the separation  $R_2O$  of the fields; a set of curves is shown for each of the  $\theta$  values considered.

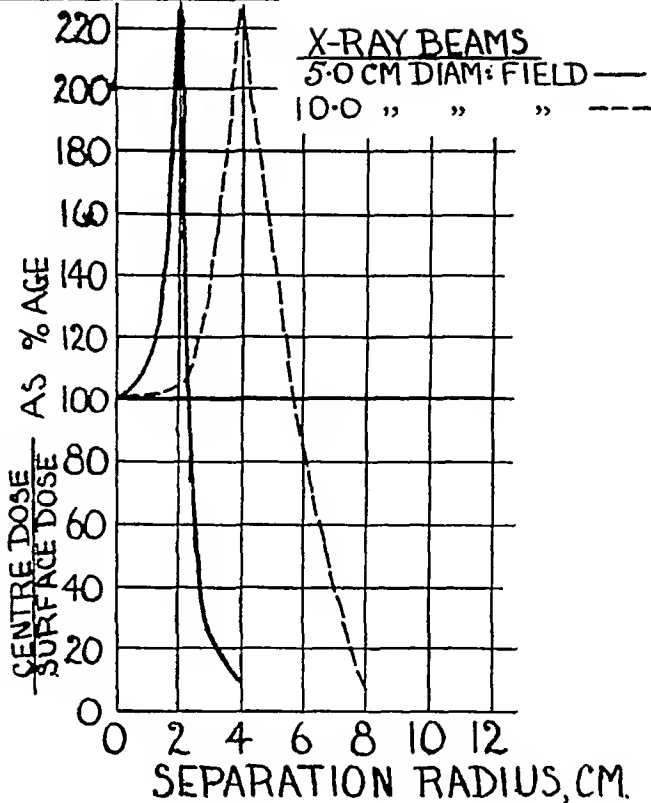
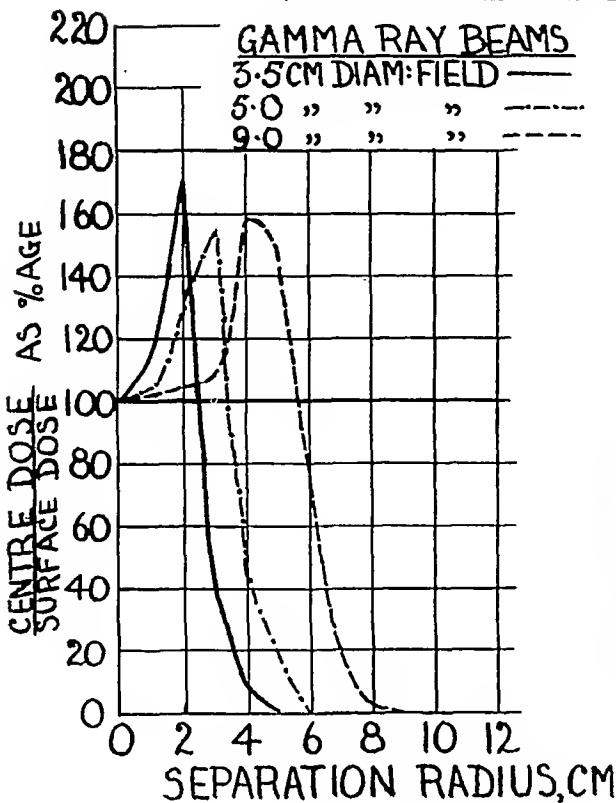
A number of useful points emerge from a consideration of these curves. First, it may be seen that certain radii of separation, in particular instances, give rise to a central dose greatly in excess of the surface dose, so that a central "hot-spot" exists. In general the severity of the "hot-spot" is greatest for the smaller angles of slope and smallest fields and least for the greater angles of slope and largest fields. Further, it is seen that in those cases where a severe central "hot-spot" does occur for a certain radius of separation, the rate of change of the ratio, with alteration of the radius, is

very great. It follows that slight alterations in the values of the radius will produce marked changes in the degree of homogeneity in the plane of entry. For these reasons, if it is desired that homogeneity should exist in this plane, considerable care must be exercised in using this technique, particularly if small fields at angles of  $15^\circ$  to  $30^\circ$  to the base are used; those values of radius of separation for which the central "hot-spots" occur most certainly should be avoided. The greater aggravation of these conditions which is seen to exist in the case of the roentgen-ray beams, is due to the fact that these are more sharply defined than are the gamma-ray beams.

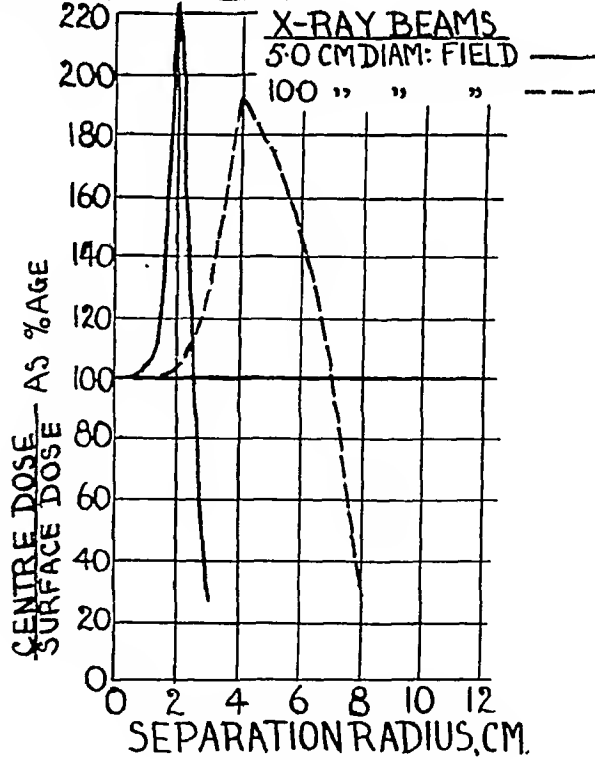
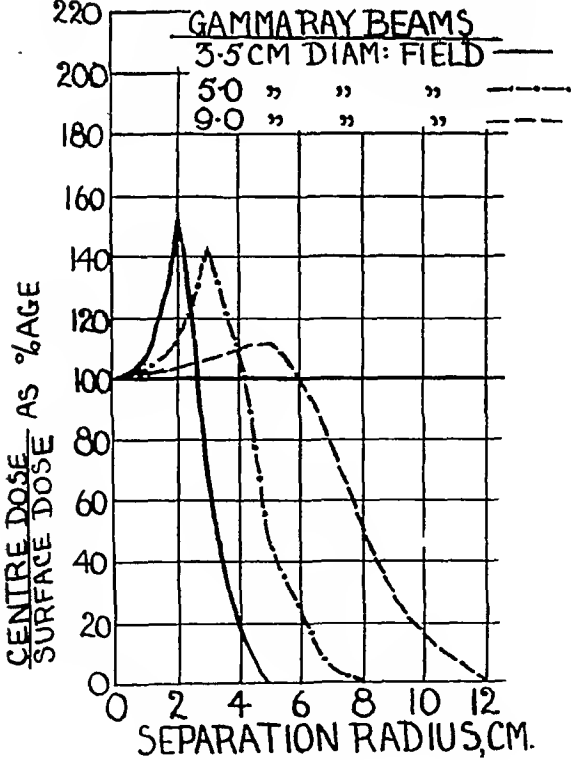
Figure 3, *B*, *C* and *D*, shows that for any angle of slope equal to or greater than  $30^\circ$ , a severe central "hot-spot" does not arise in the case of the 9.0 cm. diameter gamma-ray beam for any value of the radius of separation. It follows that in using this field one has more latitude but another disadvantage arises, namely, that for practical values of the separation radius, the center dose is always less than the surface dose for the larger angles of slope.

The case when the fields are disposed around a circle (Fig. 3 *D*) is of interest, representing, as it does, a technique that might be employed in the treatment of disease located fairly centrally within a limb, a tumor of bone, for instance. It is seen that for the gamma-ray beams the ratio does not greatly exceed unity whatever the size of field or whatever the radius of separation. Indeed, with the 5 cm. and 9.0 cm. diameter fields the center dose is always less than the surface dose so that the technique does not permit one to deliver a center dose in excess of the surface dose. When the roentgen-ray beams are arranged in this manner it is possible, with the 5 cm. diameter field, to produce a dose at the center in considerable excess of the surface dose (up to 170 per cent for 4.0 cm. separation radius), but with the 10 cm. diameter field only an added 10 per cent or so is ever achieved. The curve shows, in fact, that the three 10 cm. diameter roent-

(A) FIELDS AT 15° TO BASE



(B) FIELDS AT 30° TO BASE



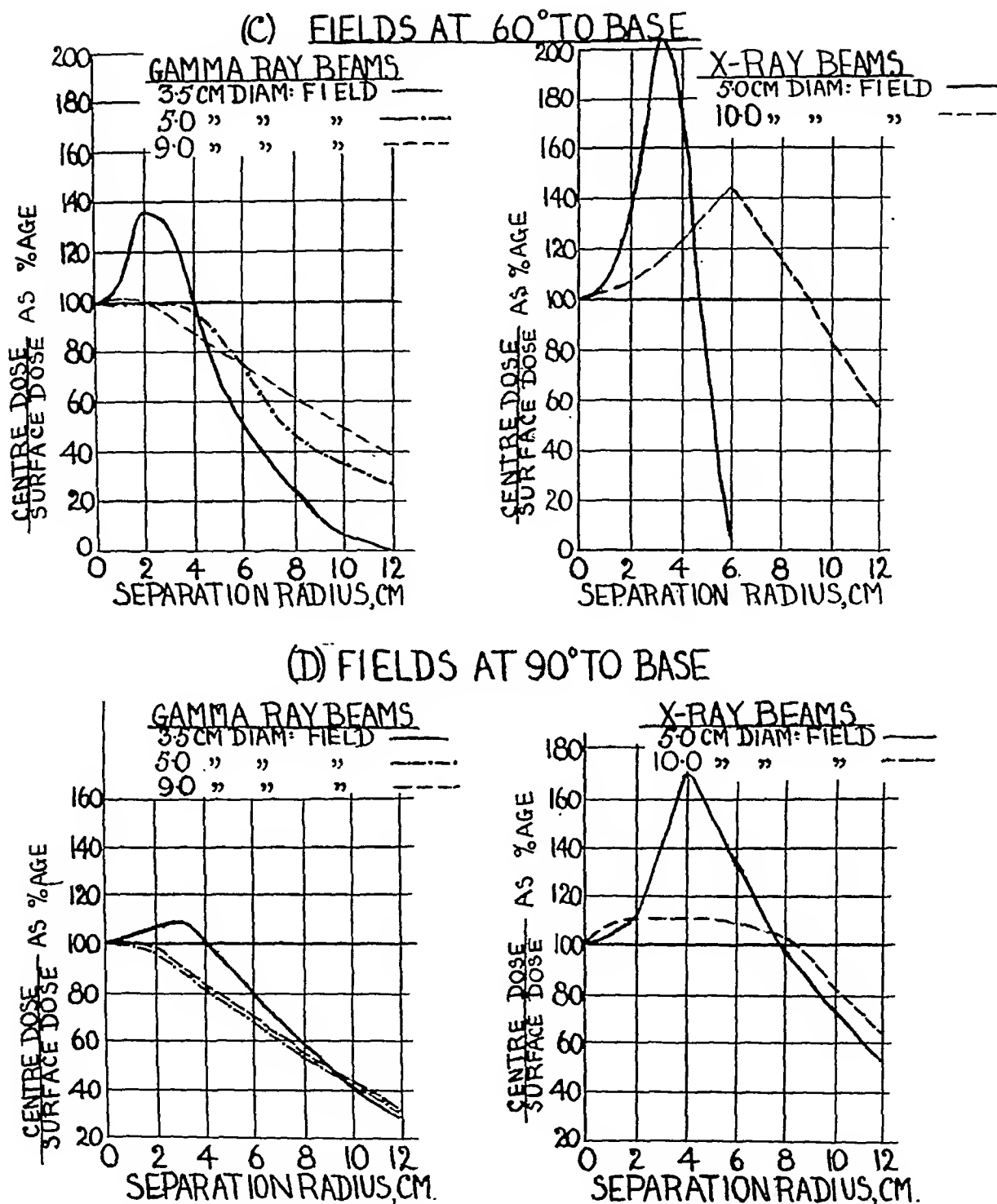


FIG. 3(A)(B)(C)(D). Curves showing the effect of the separation of the beams upon the degree of homogeneity in the plane of entry.

gen-ray beams, so arranged around a circle, give approximate homogeneity for all radii of separation from 0 to 9 cm.

#### EFFECTIVE DEPTH DOSES

Further interesting data concerning the dosage possibilities of the three field tech-

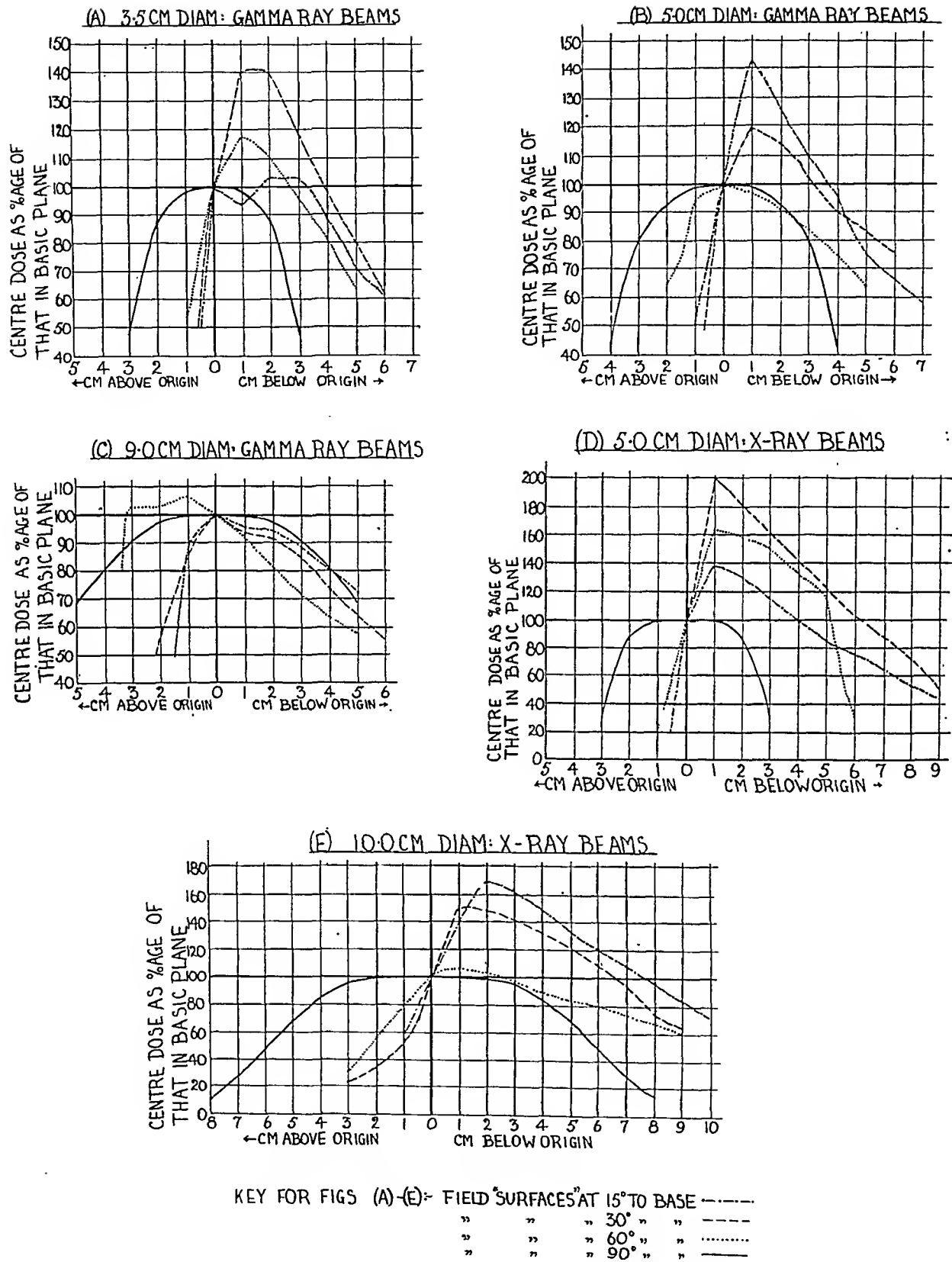


FIG. 4. Curves showing the variation of total depth dose with distance from the plane of entry (homogeneity in the plane of entry pre-arranged).

nique may be obtained by a consideration of the "total effective depth doses." For the purpose it was decided to consider those cases where maximum homogeneity exists in the plane of entry. Therefore we have considered the depth doses for the various fields and angles of slope, in each case adjusting the radius of separation of the beam centers to that value for which the center dose to surface dose ratio is equal to 100 per cent. Under these conditions the maximum possible area in the plane of entry is irradiated with the optimum degree of uniformity.

A valuable picture of the depth dosage available from the various arrangements is obtained by consideration of the variation of the dose along the central axis of the three field system, i.e., along the line *DOY* (Fig. 2). For this purpose we have determined, in each case, the total dose at points above and below *O*, and have plotted the values (expressed as a percentage of the dose at *O*) against the distance from *O*. The results thus obtained are shown in Figure 4 which gives a composite picture of the variation of total percentage depth dose with distance from *O*. The conditions examined thus appertain to the question of irradiating, uniformly, a block of tissue extending down from, and including, the skin surface to which the fields are applied. With the exception of the case where  $\theta = 90^\circ$ , they are conditions, therefore, which could arise in the irradiation of a glandular mass, particularly if ulcerating, or to other surface lesions which have invaded to some depth.

It is seen from Figure 4 that, with the exception of the specific case where the fields are arranged around a circle, the curves do not show any particular trend or regular behavior which could be related to change in the angle of slope or size of field. Indeed they afford a further striking example of the necessity of examining dosage conditions in irradiation techniques, in relation to the dose contours of the beams, before one can be sure of the distribution that will result.

In each case where the three fields are placed around a circle it is obvious that the dosage is distributed symmetrically on either side of the central plane containing the beam axes. It is seen from Figure 4 that at the distance from the central plane which corresponds to the geometrical edge of the beams the dosage value is only 60 to 70 per cent of the central dose for the roentgen-ray beams and 75 to 95 per cent for the gamma-ray beams.

The curves of Figure 4 show also, that in many cases, the total percentage depth dose may reach values considerably in excess of 100 per cent and generally these values are at depths of about 1 to 2 cm. below *O*. The change in dose with depth below *O* is consequently relatively rapid in these cases for the first 1 or 2 cm., so that adjustment of the tissues (more especially the skin surface) in relation to the fields (or vice versa) obviously must be very critical. For example, when the 3.5 cm. diameter gamma-ray beams are at  $30^\circ$  to the basic plane (Fig. 4*A*) a displacement of the skin surface from *O*, to a point 1 cm. below, would change the dose to 140 per cent of its former value and doses for all points at a depth would be less than 100 per cent of the new skin dose. In all these cases, therefore, the total depth dose, as measured with respect to the skin dose, depends very critically upon the relation of the fields to the tissues—more so than is generally realized. Figure 4*D* shows this to be so especially in the case of the 5 cm. diameter roentgen-ray beam.

Figure 4*C* brings out an important point, namely, that no matter at what angle to the basic plane one decides to use the 9.0 cm. diameter gamma-ray beam, the dose at any point below *O* is never equal to, or in excess of, that at *O*. Thus, from the point of view of depth dosage the technique is not efficient for these beams.

From Figure 4*E* it is seen that the arrangement of three 10 cm. diameter roentgen-ray beams at  $15^\circ$  or  $30^\circ$  to the basic plane gives very efficient dosage conditions. Thus, at depths of 1 to 4 cm. below *O* a depth dose of 130 to 170 per cent is ob-



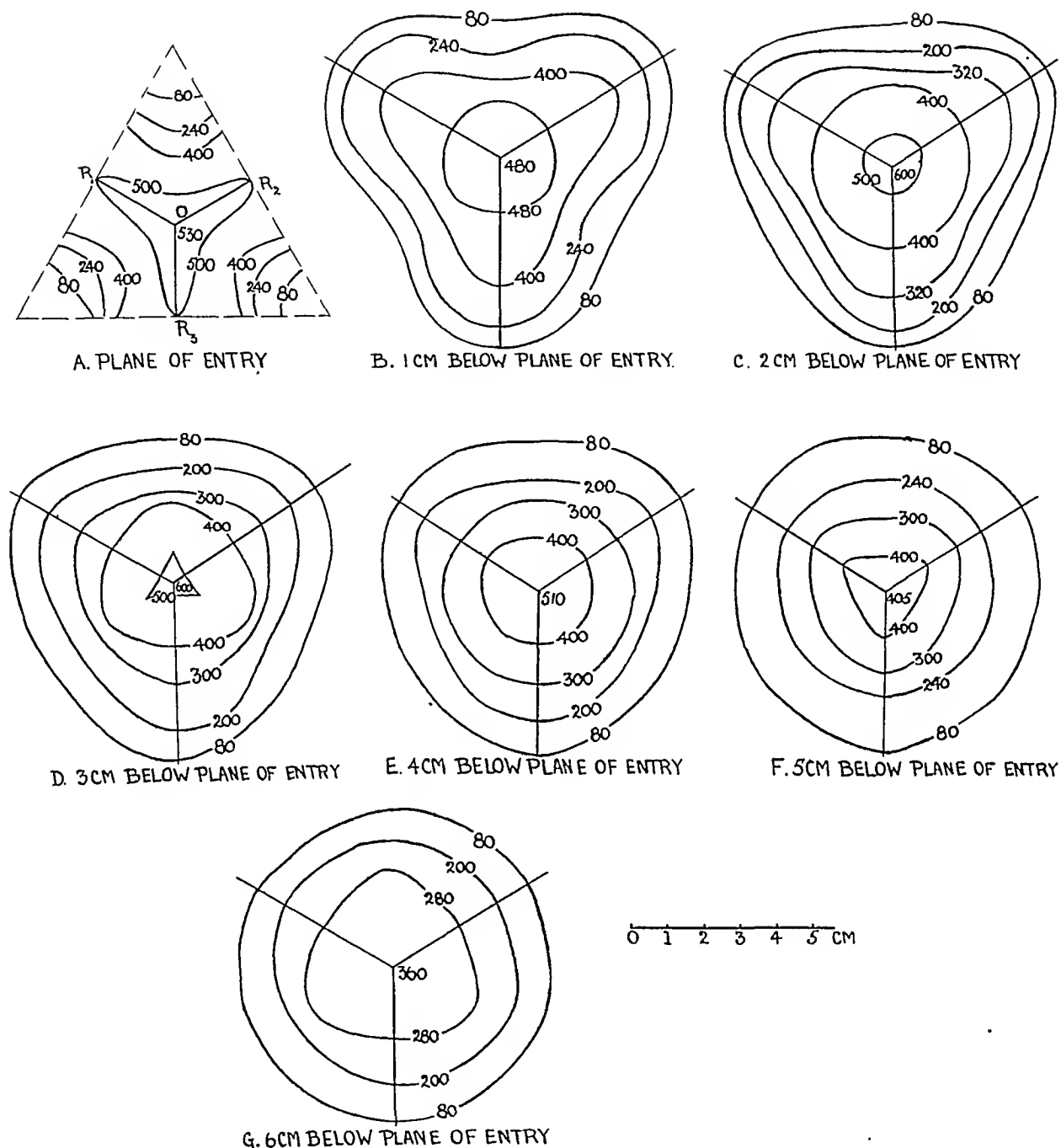


FIG. 5. Dose contours showing the three-dimensional distribution of radiation for three 3.5 cm. diameter gamma-ray beams at  $75^\circ$  to the basic plane (i.e.,  $\theta = 15^\circ$ ) and arranged to provide homogeneity in the plane of entry.

tained while the depth dose is still 100 per cent at 7 to 8 cm. depth. Angles of slope between  $15^\circ$  and  $30^\circ$  presumably will not be very different since the values for  $15^\circ$  and  $30^\circ$  run very close to one another. The values for  $\theta = 60^\circ$  are very similar to the results published by Lamerton and Mayneord<sup>3</sup> for this kind of arrangement; the slight differences are due to the fact that we have arranged our fields deliberately to give

homogeneity in the plane of entry and not at a fixed radius of separation which is independent of homogeneity. In the latter case it is seen<sup>3</sup> that depths greater than 2.5 cm. receive a depth dose of less than 100 per cent.

#### THREE-DIMENSIONAL DISTRIBUTION OF RADIATION

A consideration of the depth dose curves

(Fig. 4A) for the gamma-ray beams of 3.5 cm.\* diameter at  $15^\circ$  or  $30^\circ$  to the basic plane, suggests that these arrangements might be used profitably for the irradiation of disease in those cases where it is not too

sional distribution of radiation was made in these cases, in order to determine the total volume of tissue that would be adequately irradiated by the technique. For this examination any of the various meth-

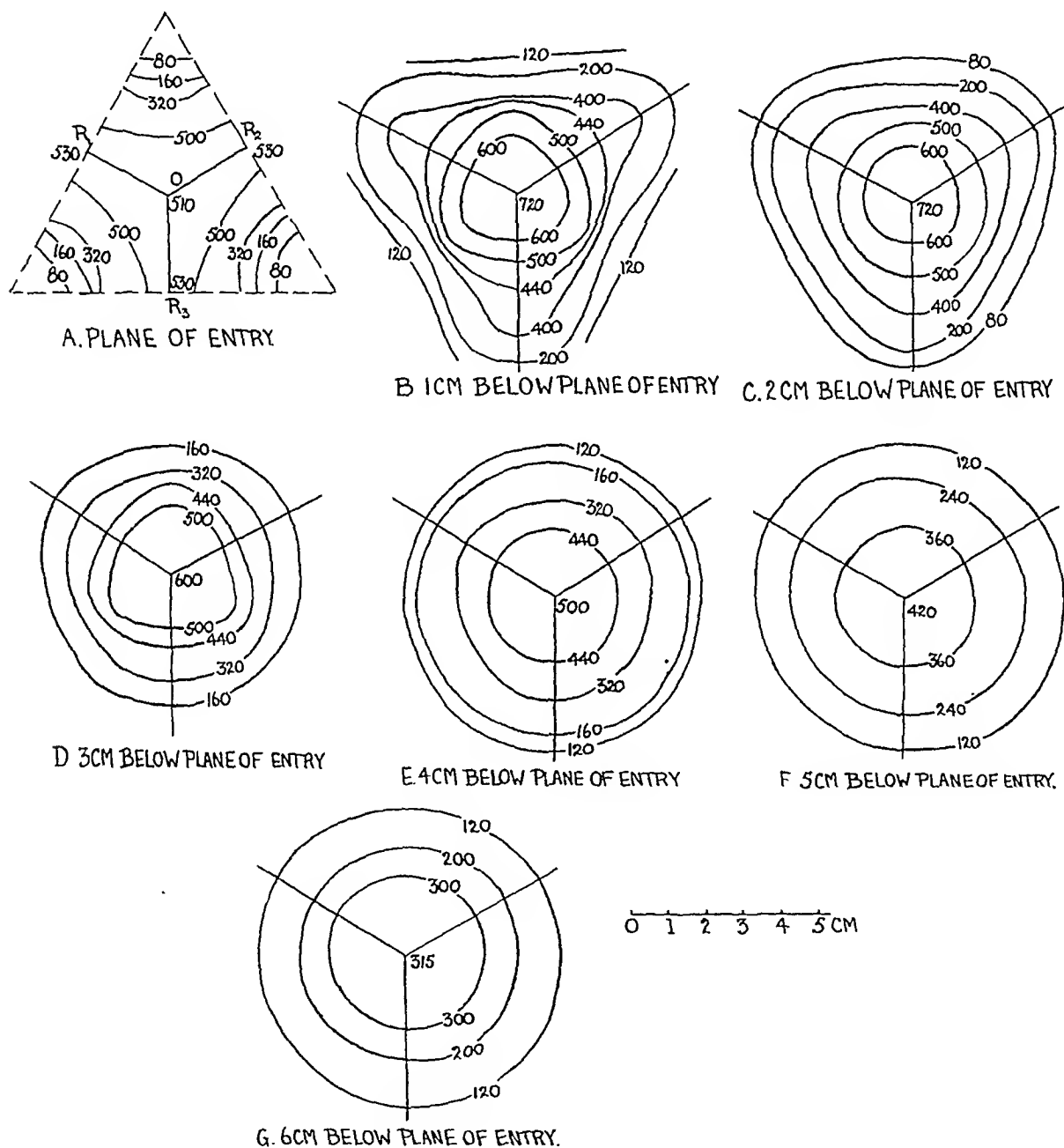


FIG. 6. As Figure 5 but the beams are at  $60^\circ$  to the basic plane (i.e.,  $\theta = 30^\circ$ ).

extensive in area, and is located near, or in the skin, from which it extends to depths from 3 to 5 cm. With this in mind, an examination of the complete three-dimen-

ods may be used;<sup>5,7,8</sup> we preferred in this instance to use the geometrical method<sup>8</sup> of projecting dose contours followed by a summation of the fields due to the individual beams.

The results obtained are shown in Figure

\* The same may be said with regard to the 5 cm. gamma ray but this is not available to us for therapy.

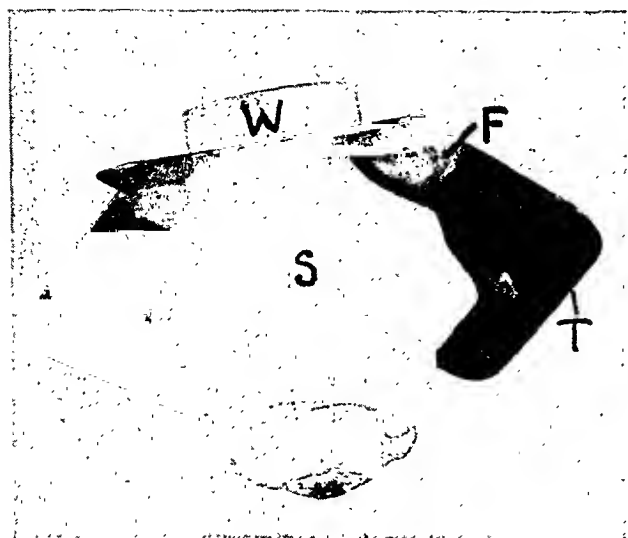


FIG. 7. Solid model of the 400 r isodose surface due to the arrangement of beams of Figure 6. The isodose surface is shown in its true relation to the surfaces to which the radium unit is applied.

5 ( $\theta=15^\circ$ ) and Figure 6 ( $\theta=30^\circ$ ) where they are expressed in terms of the dose contours in the plane of entry and in a series of planes parallel to, and at various distances below it. The dose numbers represent the dose obtained in roentgens when each of the three fields is applied for one hour, i.e., the dose delivered in three hours of total treatment. The three-dimensional distribution may be reconstructed by mounting the various planes at the correct intervals one above the other. Methods of such reconstruction which enable one to visualize the resultant isodose surfaces have been described by Mayneord and his co-workers.<sup>3,5,6</sup> One of these,<sup>6</sup> which produces a solid representation of a particular isodose surface, is to mount at the correct intervals, sheets of cardboard cut to the shape of the particular dose contour in each plane. The space between the sheets may then be filled with a suitable material (e.g., paraffin wax or plaster of paris) which is moulded to the surface of the cardboard framework to produce the isodose surface.

Figure 7 shows a model of the 400 r isodose surface obtained from the distributions of Figure 6. The surface *S* is shown mounted in its true relation to the surfaces to which the gamma-ray beams are applied;

the latter are represented by a tetrahedron constructed of sheet brass and the position of one of the beams is indicated by a cylindrical wooden disk, *W*. Since the average dose in the plane of entry is of the order of 510 r it follows that the minimum dose received by the whole of the volume within the solid is practically an 80 per cent depth dose. Models of this kind are of great value in appreciating very exactly, the volume of tissue (and its shape) which is receiving a specified quantity of radiation.

#### APPLICATION OF RESULTS TO TELETHERAPY

It was considered that the distribution shown in Figures 5, 6 and 7 could be profitably used in actual therapy if arrangements were provided for the accurate placing and directing of the beams with respect to one another and to the site to be irradiated. The advantages of using such a predetermined radiation distribution have been pointed out before.<sup>2,10</sup> They are so important as to merit re-statement. Uniform irradiation is provided to encompass a precisely known volume of tissue and the dose



FIG. 8. Illustrating the use of a tetrahedral framework for the irradiation of a tumor of the parotid.

that will be delivered to the tissue is determined before treatment commences.

To provide for the application of the beams in the clinical practice of the technique, we have used a principle described elsewhere.<sup>2</sup> This is to provide a framework or "jig" which fits over the part to be irradiated and serves to place and direct the beams of radiation. Essentially the method provides a specific and known radiation distribution within which one places the tissues to be irradiated. In this case the framework is the tetrahedron of sheet brass illustrated in Figure 7. The brass (1 mm. thick), provides the secondary filter of the radium unit, which is maintained in the correct position and direction by the cylindrical wooden disk over which the aperture of the radium unit is fitted. Since the three fields are symmetrically disposed it is necessary to provide such a disk on one surface only of the tetrahedron; when the other fields are used the tetrahedron is rotated to the corresponding position. It is seen in Figure 4A that the dosage in the zone between the plane of entry and the apex of the tetrahedron falls very rapidly below the mean value in the plane of entry. In the brass tetrahedron used for therapy this zone is filled with columbia paste to prevent the tissues falling within it. The filling *F* may be observed in Figure 7.

In clinical use the framework is applied suitably to the region to be irradiated and skin markings along the edges of the base of the tetrahedron ensure that it is placed in the same position at each treatment. The provision of a firm and robust method of fixing the framework in position which is generally applicable, has caused some difficulty, and the problem is not yet solved to our complete satisfaction. For many sites, however, we have found that zinc oxide adhesive plaster, applied to the skin across the unused surfaces of the tetrahedron, is quite satisfactory. Figure 8 illustrates the use of a tetrahedron for the treatment of a tumor of the parotid. The radium unit shown in the figure is the Westminster Hospital 2 gm. unit<sup>11</sup> and not the 4 gm.

unit to which reference has been made throughout this article. Data similar to those described have been determined for this unit also.

In conclusion, it should be pointed out that, in effect, the tetrahedral frameworks described, provide the therapist with a distribution of radiation that is known in the same sense that the distribution due to a single beam may be known. The difference is that the distribution beneath a tetrahedron is compounded from three beams and is very much more uniform than that provided by a single beam.

The author acknowledges the financial assistance given by the British Empire Cancer Campaign to the department in which this work was done.

#### SUMMARY

The total distribution of radiation resulting from the symmetrical combination of three circular radiation beams (roentgen or gamma rays) is examined and the effect of angulation, separation, and field size, is investigated.

Uniformity of dose in the plane of entry of the beams is shown to depend very critically upon the separation of the beams.

The depth doses and three-dimensional radiation distributions are examined for the case when uniformity exists in the plane of entry, in particular for the 3.5 cm. diameter gamma-ray beam.

A method of applying the results to clinical practice is described.

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# PHOTOROENTGENOGRAPHIC TECHNIQUE AND DARK ROOM PROCEDURE USED AT THE ARMY RECRUITING AND INDUCTION STATION, NEW HAVEN, CONNECTICUT

By MAJOR CHARLES C. VERSTANDIG, *Medical Corps, Army of the United States, and*  
CORPORAL C. W. AINSWORTH, *Medical Department, Army of the United States*

PHOTOROENTGENOGRAPHIC technique and surveys are comparatively new. We have been quite fortunate in observing various methods of technique and feel that we may be able to offer a uniform procedure for photoroentgenographic technique which has proved to be quite satisfactory.

Upon arriving at the x-ray caption table the inductee's name, address, x-ray number, age, color, and weight are typed on his caption sheet.

NEW HAVEN ARMED  
FORCES INDUCTION  
DISTRICT  
17 December 1943  
LEFT

John Doe  
— — Street  
Waterbury, Conn.  
X-34708  
W-33-126

The caption sheet is made more legible with the aid of a sheet of carbon paper, the purpose of which is to make the writing on the caption as dark as possible; this in turn makes it much easier for the roentgenologist to read the information recorded on the roentgenogram.

The posteroanterior measurements of the chest in centimeters are taken during the inspiratory phase and the number recorded over the left scapular region of the inductee with a skin pencil. No roentgen examinations are done at this station without the thickness of the patient's chest first being measured in centimeters. The caliper is placed under the man's arm next to his chest with the immovable arm placed flat against the scapula. The movable member of the caliper is then placed so that it just touches the areolar tissue of the mammary gland of the individual. The measurement is taken on inspiration and recorded on the skin over the left scapular area.

On entering the roentgenographic room, the caption sheet is placed in the right cap-

tion holder, with the writing facing the examinee. The reason for this is to produce a true stereoscopic image in order to facilitate reading the caption sheet in the orthostereoscope. The left caption holder contains the name of the organization, address and date as well as the word "LEFT." The technician then places the inductee's chin on the chin rest and moves the fluorescent screen up or down to center the patient comfortably. The inductee is then asked to put his feet together, flat on the floor, and stand to midwidth of the film in order to obtain a perfect vertical alignment. The acromial processes are centered approximately 3 inches below the upper border of the cassette. The inductee's hands are placed on his iliac crests with the dorsa resting on the hips. The shoulders are then dropped into a normal position and the elbows flexed and forward. The tube is then turned in the "down" position, with the central beam passing directly through the center of the fluorescent screen. This is determined by the scale on the stand of the photoroentgen unit. When the scale numbers on this unit and the tube stand are the same, the central beam of the first exposure will pass directly through the center of the fluorescent screen. The technician then runs his hands along each side of the patient's chest to make sure that the patient is well within the fluorescent area. One technician then returns to the back of the photoroentgenographic unit and inserts a cassette, locks it in position, removes the guard, and places the film in the "down" position. This technician then steps behind a portable, mounted lead screen. The lead screen dimensions are 3 by 6 feet. The second technician goes to the control panel, steps behind another

mounted lead screen of the same dimension, looks through the lead glass window, notes the centimeter thickness recorded on the back of the inductee (in skin pencil) and sets the machine for the proper amount of kilovoltage. This technician then requests the man to "take in a deep breath, and hold it." The first exposure is then made. The tube and the film are then shifted up 4 inches; this complete shift is made by an electromagnetic control. The same technician then asks the man to "hold steady." A period of from eight to twelve seconds is allowed to elapse before the second exposure is made. The length of time between exposures serves a two-fold purpose: first, the tube is given a chance to stop vibrating, second the tube is given a chance to cool. If more time were taken between exposures there would be considerable motion on the film, because of the natural tendency for the selectee to breathe.

After the second exposure is made, the film guard is replaced in position with the "black topped" edge out, and the cassette holder is unlocked. The cassette is reversed, the film guard removed, the cassette holder placed in the down position and the next inductee is placed in position. When both sides of the cassette have been exposed, it is placed in the lead lined by-pass for developing.

This department believes a diagnostic roentgenogram must contain the following factors: (1) maximum of detail, (2) minimum of distortion, (3) medium of contrast, and (4) the proper amount of density.

The control stand is the General Electric Model KX-11. The tube is General Electric Model DX Coolidge Tube with a double focal spot of 2.2 and 4.2 millimeters square.

The unit also consists of a high voltage transformer. The rectifier is a four kenotron full wave type and delivers a pulsating direct current to the roentgen tube. We employ the 200 ma. and one-fifth second technique for chests measuring up to 28 cm. in thickness. For chests measuring over 28 cm. in thickness, the milliamperage is

dropped to 150 ma., and the time is increased to two-fifths of a second.

For our chest photoroentgenograms we employ the 36 inch focal film distance without a grid.

This department adheres to an eighty man an hour output with the help of an auxiliary fan to keep the tube cool in addition to the blower attached to the tube head. We found that the rate of heat dissipation is greatly accelerated by the addition of this auxiliary fan which increases the air flow over the surface of the casing. It has been found that roentgenographing a greater number of men per hour results in heat input in excess of heat capacity, thereby increasing the temperature of the parts with consequent danger to the tube and the possibility of its destruction.

If the grid were used, less men would be roentgenographed per hour. We make an honest and concerted attempt to keep the heat units of the tube at a maximum of one-half million (kv., peak,  $\times$ ma.  $\times$ sec.) per thirty minutes.

The long axis of the focal spot of the tube is horizontal to the floor with the target end aligned to the sixth thoracic vertebra. This also aids in helping keep the roentgen tube cool.

The roentgenographic room is so arranged that the tube stand may be turned to a 90 degree angle for the purpose of taking 14 by 17 inch roentgenograms when indicated.

One member of the dark room "team" takes the film out of the lead lined by-pass, removes the guard from the cassette as well as the film and turns the guard around so that the white side is out. He then passes the exposed film on to the man who places it in the developing hangers, using the utmost caution to touch only the corners of the film. The first member of the team now reloads the cassettes and places the films in the film bin. To load a cassette, the protective black paper is removed from around the film and the film inserted into the cassette with the emulsion side of the film out so that it will receive the roentgen rays on



exposure. The back side of this single emulsion film is of a nonhalation composition. The film is inserted into the cassette by bending the open ends of the black protective paper back to the end of the film. The film is then inserted under the guides and moved into position. The bottom guard is locked, the film guard put in position with the white topped edge out, and returned to the unexposed side of the by-pass.

A thermometer is constantly kept in the developing tank in order to maintain a very close and constant check on the temperature of the developer at all times. The safe light over the work bench is of the Wratten Series Six B. The distance from the safe light to the work bench is 36 inches. At this distance, exposed film could lie on the work bench for a period of twelve minutes before any light fog would be seen on the processed film.

The developing solution is stirred the first thing in the morning and several times throughout the day. In this way none of the unexposed silver nitrates have a chance to settle to the bottom of the developing tank. Water is run continuously into the wash compartments of the tank at the rate of twelve complete changes per hour. All the water entering the wash tanks has been run through the water cooler. This cooler is governed to the mean temperature and pressure of the city water. The water enters the wash tank at a constant temperature of 68° F. The water is left running twenty-four hours a day, six days a week. On Sunday evenings just before the charge of quarters closes the building, he is instructed to start the water cooler. In this way the temperature of the developer and the fixer is maintained at 68° F. for processing the films the next day. This department feels that only through such a procedure can the temperature of the developer and fixer be kept constant.

The developer used is Eastman Kodak. A close check is kept on the number of 4 by 10 inch, and 14 by 17 inch films processed (one 14 by 17 inch is calculated to be equal to five 4 by 10 inch films). When

the combined number of films developed is equal to one thousand 4 by 10 inch films the solutions are discarded. At this time, 10 ballons of fresh developer are prepared and placed in the cleansed developing tank. An extra 5 gallons are prepared at the same time to be used as replenisher. A fresh 15 gallon tank of fixer is made at this time and placed in the cleansed fixing tank.

Films are developed exactly according to time and temperature technique only. The films after developing are allowed to remain in the fixing bath for a period of fifteen minutes. They are then transferred to the wash tank, and are washed for a period of thirty minutes. The films are then placed in the dryer.

No films are read at this induction station in a wet, damp or sticky condition.

By the time the roentgenologist is ready to read the roentgenograms, all the films have been processed, dried and placed in x-ray numerical order. In this manner the roentgenologist can read the man's name and x-ray number at a reasonable rate of speed. Two men work with the roentgenologist in the reading room. One man records the findings opposite the man's name on a special check list, while the other man files the roentgenogram the roentgenologist has just read. Envelopes are prepared ahead of time. These envelopes bear the man's name, home address, daily tag number, x-ray number, the words "essentially negative," the man's Army serial number, Medical Section, New Haven Armed Forces Induction District and are ready for transmittal to the Veteran's Administration in Washington, D. C.

#### WAR DEPARTMENT

John Doe L.B. III X-100000  
18 Osborn St., New Haven, Conn. 172  
Official Business

ASN  
703295

#### MEDICAL SECTION

New Haven Armed Forces Ind. Dist.  
Orange Street Armory  
Essentially Negative New Haven, Conn.

Any individual whose roentgenogram revealed any questionable evidence of a

pathological condition of the chest is "called back" for a 14 by 17 inch stereo-roentgenogram of his chest. If after further study of the 4 by 10 inch film with the 14 by 17 inch film, any pathological process is revealed, the roentgenologist interviews the man in the film reading room, obtains a history and records the case on our standard forms—with complete roentgenographic findings.

INTERPRETATION OF CHEST ROENTGENOGRAM

Date 17 December 1943  
NAME John Doe X-ray #100,000  
ADDRESS 18 Osborn St., New Haven, Conn. Age 20  
FAMILY PHYSICIAN Dr. Richard Roe Sex M  
ADDRESS 19 Filbert Street, New Haven, Conn. Race W  
General Characteristics of Film: Satisfactory  
(Bony thorax, extrathoracic, mediastinum, diaphragm, right lung, left lung, impressions.)

CHARLES C. VERSTANDIG, M.D.

Impressions only are given in this interpretation of shadows seen on the roentgenogram. A diagnosis should be made only after all factors have been taken into consideration. A clinical diagnosis of tuberculosis is reportable to the Health Officer.

The man is then advised to consult his family physician for further study. He is also told that a copy of the report is sent to the State Tuberculosis Commission and that this Commission will get in touch with him, as well as his family physician, in the very near future.

The roentgenograms of men with a pathological condition in the chest are distributed as follows: one of the 14 by 17 inch films is sent to the State Selective Service Commission, the other with the 4 by 10 inch film accompanied by the roentgenologist's report is sent to the State Tuberculosis Commission.

Once a week the 4 by 10 inch cassettes as well as the 14 by 17 inch cassettes are cleaned. Minor repairs are made at this time, if necessary. Each evening before the dark room "team" is through, all the developing hangers that have been used during the day are thoroughly washed, dried and hung ready for use the next day.

We have found that by these standard rules and routines we are able to obtain a highly satisfactory type of photoroentgenogram.



# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: LAWRENCE REYNOLDS, M.D.

Assistant Editor: RUTH BIGELOW, B.S.

Editorial Board: A. C. CHRISTIE, M.D. E. H. SKINNER, M.D. LAURISTON S. TAYLOR

Advisory Board for Pathology: EUGENE L. OPIE, M.D.

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*Assistant Editor*: Ruth Bigelow, 110 Professional Building, Detroit 1, Mich.

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*Advisory Board for Pathology*: Eugene L. Opie.  
*Forty-fifth Annual Meeting*: 1945, to be announced.

### AMERICAN RADIUM SOCIETY

*President*: William E. Costolow, Los Angeles, Calif.; *President-Elect*: Charles L. Martin, Dallas, Texas; *1st Vice-President*: Frank E. Adair, New York, N. Y.; *2nd Vice-President*: Eugene P. Pendergrass, Philadelphia, Pa.; *Secretary*: A. N. Arneson, 4952 Maryland Ave., St. Louis, Mo. (*Acting Secretary*, E. H. Skinner, 1532 Professional Bldg., Kansas City, Mo.); *Treasurer*: Leland R. Cowan, 606 Medical Arts Bldg., Salt Lake City, Utah.

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*Representatives on American Board of Radiology*: Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

*Twenty-eighth Annual Meeting*: 1944, to be announced.



# EDITORIALS



## JOINT MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY AND THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

FROM September 24 to 29, 1944, the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America was held at the Palmer House in Chicago, Illinois. There had been skeptics who doubted the wisdom and even the possibility of holding a satisfactory war time meeting in the face of such difficulties as limited food supplies, overtaxed transportation facilities and crowded hotel accommodations. The resulting session is the best answer to the critics, for the meeting which was brought about by the combined efforts of the various committees, and especially the Coordinating Committee, surpassed the hopes of the most sanguine and stilled the criticisms of the most cynical.

Despite transportation problems, the attendance was large (a registration of over 1,200) and those fortunate enough to attend seemed to be conscious of their privilege and desirous of making the most of the meeting denied them in 1943.

All sessions were well attended, and during intermissions the Scientific and Commercial Exhibits were objects of unusual attention.

The Refresher Courses, held Sunday afternoon and evening and every morning during the week day sessions, were filled to capacity, many of those desiring to attend being turned away. Dr. Warren W. Furey is to be congratulated on the variety of practical subjects and the excellent teaching talent he procured for these invaluable instructional and review courses.

Dr. Sherwood Moore, President of the American Roentgen Ray Society, was in

the chair at the first general assembly, introducing Dr. J. J. Moore, President of the Chicago Medical Society, who welcomed members and guests to Chicago in a very generous and appropriate manner. Dr. E. R. Witwer, President of the Radiological Society of North America, and Chairman of the Coordinating Committee, responded with a few well chosen remarks. The scientific part of this program included addresses by Dr. Herman L. Kretschmer, President of the American Medical Association, Colonel B. R. Kirklin, representing Major General Kirk, the Surgeon General of the Army, and Lieutenant Commander Robert K. Arbuckle representing Vice Admiral McIntyre, the Surgeon General of the Navy.

On Tuesday morning, with Dr. Witwer presiding at the general assembly, Dr. Lyell C. Kinney of San Diego, California, was installed as President of the American Roentgen Ray Society.

On Wednesday morning at the general assembly, Dr. E. R. Witwer of Detroit, Michigan, delivered his address as President of the Radiological Society of North America.

All morning assemblies were of general interest with suitable addresses by outstanding medical men. Afternoon sessions were in sections—Diagnosis and Therapy—enabling a choice of attendance at lectures of particular interest to the individual.

In keeping with the times and due to the fact that so many Society members are in Service, a large number of the essayists were members of the Armed Forces, and

their subjects were of special interest for their military application or because they drew largely on military experience for their material.

A highlight of the Joint Meeting was the annual memorial lecture, this year appropriately combined as the Caldwell-Carman Lecture, given by Dr. Lawrence Reynolds, Director of the Department of Radiology, Harper Hospital, Detroit, Michigan. Dr. Reynolds chose for his subject "The History of the Use of the Roentgen Ray in Warfare," and he delineated the salient facts about the development of roentgen apparatus and its early and gradual introduction to warfare until it attained its present high efficiency and universal use, including a discussion of the high voltage equipment invaluable in the inspection of the planes and guns produced in our war plants. Dr. Reynolds interspersed his lecture with lantern slides illustrating the crude equipment of the early days, and added to the scholarly nature of his address by giving the historical and geographic background of the early military campaigns in which roentgen rays were first used, including topographic maps and old photographs of actual scenes. At the conclusion of his lecture, Dr. Reynolds was presented with a testimonial scroll by Dr. Witwer on behalf of the two societies.

To those fortunate enough to be in attendance, the Annual Banquet on Thursday, September 28, was a memorable occasion. Dr. E. L. Jenkinson presided and Dr. Franklyn B. Snyder, President of Northwestern University, was the principal after-dinner speaker. Officers of both societies were presented to the assemblage and Dr. Lewis G. Allen, of Kansas City, was installed as President of the Radiological Society of North America. Dr. Clarence E. Hufford, Chairman of the Committee on Scientific Exhibits, who with his coworkers collected an unusually large and interesting group of exhibits for the session, presented the awards of merit for the

exhibits declared most meritorious by the judges.

The First Award was given to Drs. Eugene P. Pendergrass, John Q. Griffith and Nicholas Padis, Robinette Foundation, Hospital of the University of Pennsylvania, Philadelphia, for their instructive and well presented work on "Pituitary Irradiation Controlled by Biologic Tests." This is an important contribution to radiation therapy, eliminating much of the inaccurate and unpredictable from such treatment.

The Second Award was given to Drs. L. L. Robbins and C. H. Hale, Massachusetts General Hospital, Boston, for their very practical demonstration of variously located atelectases of the lungs. Their exhibit was entitled "The Roentgen Appearance in Collapse of the Lung and its Subdivisions."

The exhibit by Paul S. Henshaw, Ph.D., National Cancer Institute, Bethesda, Maryland, entitled "Radio-leukemia" received the Third Award. It graphically showed the effect of irradiation on blood cells, using an irradiated mouse and a Geiger counter. Every radiologist, no doubt, felt a personal interest in this exhibit with its warning of the possibility of development of leukemia as the result of repeated casual exposure to roentgen rays or radium.

Drs. Samuel G. Henderson and Louise S. Sherman, Elizabeth Steel Magee Hospital, Pittsburgh, earned First Honorable Mention for a beautiful demonstration of the "Roentgen Anatomy of the Skull in the Newborn Infant."

Dr. Robert B. Taft, Charleston, South Carolina, had an interesting exhibit on "Radium Contamination of Film Boxes" which gave him Second Honorable Mention, and should give him heart-felt thanks from harried roentgenologists as well as producers of roentgen films.

Commander Carleton B. Peirce and his group of officers from the Royal Canadian Navy received Third Honorable Mention

for their exhibit on "Arthrography of the Knee," showing interesting conditions revealed by pneumography.

The judges must have had a difficult time in arriving at their decision for most of the exhibits had special attraction because of completeness and timeliness of subject.

Thirty manufacturers expressed their interest in the meeting by being represented in the Commercial Exhibit. Their displays were the finest seen at any radiological meeting, and much of interest and educational value was shown.

The members and guests who attended the Joint Meeting owe a debt of gratitude to the officers and committees for their

courage, foresight and tireless industry in overcoming so many difficulties and providing such an enjoyable and profitable session. Thanks also are due to those who took time out of their busy practice to prepare papers and exhibits for the scientific program.

The Palmer House and its personnel also deserve the thanks and gratitude of the Joint Meeting for their efficiency under war time difficulties. Their efforts contributed greatly to the smooth running of all phases of the meeting which will be a memorable one.

E. W. HALL





FREDERICK C. MARTIN  
1884-1944

FREDERICK C. MARTIN, Manager of the Medical Division of the Eastman Kodak Company, Rochester, New York, died on August 20, 1944, at the age of fifty-nine, after many months of illness. He was born on November 2, 1884, in Philadelphia, Pennsylvania, where he obtained his education and early business training. He became

interested in photography, particularly in the color processes then in use, and in 1914 he associated himself with the Hess-Ives Corporation, a Philadelphia photographic research firm. While with that organization Mr. Martin had the opportunity to become closely acquainted with commercial photography, especially photoengraving. This



knowledge later helped him to maintain high standards of reproduction in the publications of the Kodak Medical Division.

Mr. Martin became associated with the Eastman Kodak Company November 8, 1916, and was first employed in the Photographic Department of the Kodak Research Laboratories at Rochester, New York. During World War I he was an instructor in the Army School of Aerial Photography which was located in Kodak Park. He became increasingly interested in roentgenography and he began a period of work in the X-ray Department of the Kodak Research Laboratories. From there, in 1920, he went to the Sales Department at Kodak Office and was appointed Assistant Manager of the Medical Division a short time afterward. He was made Manager of the Division in November, 1929, a position which he held until his death.

Mr. Martin was unsparing in the employment of his knowledge, understanding

and energy, both in directing the work of his sales force and in carrying on his own business contacts. His pleasant personality, keen sense of humor, and helpful guidance in technical matters earned for him the friendship and esteem of radiologists and his colleagues among roentgen-ray equipment manufacturers throughout the country. Continual study made him responsible for many technical developments in the roentgen-ray field, such as improvements in film usefulness, standardization of processing room procedures and design of accessories.

Mr. Martin was a faithful attendant at the various radiological meetings where he was always most welcome both because of his congenial personality and for his many helpful suggestions to radiologists in solving their problems. Mr. Martin's death is a distinct loss to radiology and his place will not be an easy one to fill.

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# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer.*

## MEETINGS OF ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary*, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: 1945, to be announced.

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary*, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary*, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio.

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary*, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1945, to be announced.

#### RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

*Secretary*, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

#### SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

*Secretary*, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.

#### RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

*Secretary*, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

#### SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

*Secretary*, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

#### RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION

*Secretary*, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

#### RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

*Secretary*, Dr. Roy G. Giles, Temple, Texas.

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary*, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

#### CHICAGO ROENTGEN SOCIETY

*Secretary*, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary*, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary*, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.

#### DENVER RADIOLOGICAL CLUB

*Secretary*, Dr. Edward J. Meister, 366 Metropolitan

Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary*, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

#### FLORIDA RADIOLOGICAL SOCIETY

*Acting Secretary*, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary*, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

#### INDIANA ROENTGEN SOCIETY

*Secretary*, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meeting held the second Sunday in May annually.

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary*, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary*, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

#### NEBRASKA RADIOLOGICAL SOCIETY

*Secretary*, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

#### NEW ENGLAND ROENTGEN RAY SOCIETY

*Secretary*, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

#### RADIOLOGICAL SOCIETY OF NEW JERSEY

*Secretary*, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

#### NEW YORK ROENTGEN SOCIETY

*Secretary*, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

#### NORTH CAROLINA ROENTGEN RAY SOCIETY

*Secretary*, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

\* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

## NORTH DAKOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. L. A. Nash, St. John's Hospital, Fargo.  
Meetings held by announcement.

## CENTRAL NEW YORK ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse.  
Three meetings a year, January, May, November.

## OHIO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio.

Meets at time and place of annual meeting of Ohio State Medical Association.

## PACIFIC ROENTGEN SOCIETY

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

## PENNSYLVANIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. L. E. Wurster, 416 Pine St., Williamsport.

## PHILADELPHIA ROENTGEN RAY SOCIETY

*Secretary*, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

## PITTSBURGH ROENTGEN SOCIETY

*Secretary*, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

## ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

## ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

*Secretary* Dr. A.M. Popma, 220 N. First St., Boise, Idaho.

## ST. LOUIS SOCIETY OF RADIOLOGISTS

*Secretary*, Dr. E. W. Spinzig, 2646 Potomac, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

## SAN DIEGO ROENTGEN SOCIETY

*Secretary*, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

## SAN FRANCISCO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Martha Mottram, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Toland Hall, University of California Hospital, second six months at Lane Hall, Stanford University Hospital.

## SHREVEPORT RADIOLOGICAL CLUB

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

## SOUTH CAROLINA X-RAY SOCIETY

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

## TENNESSEE RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

## TEXAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, January 17, 1945.

## UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

## UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

## VIRGINIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

## WASHINGTON STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

## X-RAY STUDY CLUB OF SAN FRANCISCO

*Secretary*, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

## CUBA

## SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

## BRITISH EMPIRE

## BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

## SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

## FACULTY OF RADIOLOGISTS

*Secretary*, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

## SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

## RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

## CANADIAN ASSOCIATION OF RADIOLOGISTS

*Secretary*, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton, Alberta.

## SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

## RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

## SOUTH AMERICA

## SOCIEDAD ARGENTINA DE RADIOLOGIA

*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

## CONTINENTAL EUROPE

## SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

## SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

*Secretary* for French language, Dr. A. Grosjean La Chaux de Fonds.

*Secretary* for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

## SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

*Secretary*, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

## ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

## LENINGRAD ROENTGEN RAY SOCIETY

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

## MOSCOW ROENTGEN RAY SOCIETY

*Secretaries*, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

## SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

## MECHANISM OF DEGLUTITION

TO THE EDITOR:

In a recent number of this JOURNAL\* was published an abstract of an article in which the ability of a man to swallow while standing on his head was ascribed as being due to "suction."

During 1941 we prepared a cinefluorographic film on the mechanism of deglutition. When we came to the part in which we wanted to demonstrate the peristaltic action of the human esophagus, we arranged a stand above the fluorographic machine so that the subject could hang his head and body downward in front of the screen, supported by his legs on top. The fluid to be swallowed was placed in a glass on a low table below the edge of the screen and drawn into the mouth through straws. This was tried by a large number of interns and nurses in addition to the laboratory personnel and some general by-standers. It was found that everyone who tried could do it. Finally two intern-volunteers, who were chosen primarily because of their slight stature and thin chest measurements, were photographed in the act. Figure 2 is a print from the resulting movie.

It was found necessary to use an unusual projection angle in order to get the shadow of the esophagus well away from the spine and the great vessels. In this print, the body is somewhat inclined and the direction of the beam through the body is postero-anterior and right-to-left oblique. The left side of the chest is against the screen. It was found that in carrying the heavy barium mixture upward, the motion of the esophagus was much more than the usual fluoroscopic image would lead anyone to expect and that in any other position tried, some part of the course was obscured.

The man drew the barium mixture into his mouth by extending the rigid jaw structure and withdrawing the tongue to produce a potential space into which atmos-

pheric pressure pushed the fluid. He then reversed the process and, by means of the usual muscular contractions, projected the fluid into the lower end (i.e., normally the upper end) of the esophagus. At this point it formed a bolus which was then carried upward by a peristaltic wave and de-



FIG. 1.

posited more or less completely in the stomach. In the case of the man, usually a small amount of the fluid ran back and was picked up by the succeeding wave.

Quadrupeds normally drink with the cardiac end of the stomach higher than the mouth. A cat, having had much more prac-

\* Robinson, T. A. A note on the mechanism of deglutition. *Brit. J. Radiol.*, 1942, 15, 209-210. Abs. in *AM. J. ROENTGENOL. & RAD. THERAPY*, August, 1944, 52, 230.

tice of course, put on a better demonstration than the man. The cat used no suction whatever, but employed a two-stroke-cycle reciprocating mechanism of the jaw, tongue and throat muscles. The cat threw a large drop of the fluid to the back of his mouth with a quick flip of his tongue and forced



FIG. 2.

it into the lower end of the esophagus by the same swallowing mechanism as the human. This was done very quickly and very rapidly. The drops collected in the lower end of the esophagus which served as reservoir and was partially filled at all times while the animal was drinking.

Peristaltic waves originated about midway of this "reservoir" and each carried a large, clear bolus up to the stomach. The rate of travel was quite slow and quite non-uniform; they were timed all the way from five to eight seconds. Usually the wave slowed down, sometimes coming practically to a stop, when the leading end of the bolus encountered the cardiac sphincter, then it would speed up again and the bolus disappear into the stomach. At rare intervals some of the fluid would escape through the wave constriction and run back down the esophagus, in which case it always ran all of the way back to the "reservoir." There never appeared to be more than one wave in motion at a time; this in contrast to the human.

The man finally emptied his esophagus by a series of little peristaltic waves which ran up in quick succession, after he finished swallowing. The cat put a final touch to his meal by raising his head, stretching his neck and giving one last strong gulp, evidently with great satisfaction.

Two prints from the moving picture film are shown. In Figure 1 are to be noted the "reservoir," the clear bolus, and the partially filled stomach. In Figure 2, the esophagus appears partially filled throughout its length, as the waves succeed each other very closely and are not so clear-cut. It is to be noted also that the change from one frame to the next indicates how much faster the waves are travelling.

Department of Radiology  
Harper Hospital  
Detroit, Mich.

K. E. CORRIGAN  
H. S. HAYDEN

## UROLOGY AWARD

The American Urological Association offers an annual award "not to exceed \$500" for an essay (or essays) on the result of some specific clinical or laboratory research in Urology. The amount of the prize is based on the merits of the work presented, and if the Committee on Scientific Research deem none of the offerings worthy,

no award will be made. Competitors shall be limited to residents in urology in recognized hospitals and to urologists who have been in such specific practice for not more than five years. All interested should write the Secretary for full particulars.

The selected essay (or essays) will appear on the program of the forthcoming June meeting of the American Urological Association.

Essays must be in the hands of the Secretary, Dr. Thomas D. Moore, 899 Madison Avenue, Memphis, Tennessee, on or before March 15, 1945.

MILEY B. WESSON, *Chairman*  
*Committee on Scientific Research*

## DIRECTORY OF MEDICAL SPECIALISTS

The biographic data of the first two editions of the Directory of Medical Specialists included only positions (internships, residencies, or assistantships) held during the course of training of men up to the time of their certification by the American Boards, and hospital and medical school staff positions then currently held.

It is desired to extend these data in the Third Edition to include all formal hospital and medical school appointments, with dates held, even though now resigned, as well as records of all military service including commissions and dates, either in World War I, peace-time in the Reserve forces, or in the present war.

Thus, a chronologically complete sketch of a Diplomate's entire career is to be included in this Third Edition of the Directory.

Membership or fellowship in national or sectional (not local) special societies, and national general societies with offices held, and dates, in any of these, should be reported.

Membership in recognized international medical societies may be included, but honorary or other membership in foreign medical societies should not be reported.

Reference to the Second Edition (1942) of the Directory may be made for lists of

medical societies to be included in one's biographic sketch.

Families or secretaries of men absent in military service are asked to complete or correct previous listings or new forms now being mailed to those eligible for inclusion in the Directory. Only those certified by an official American Board can be included, and there is no charge for this listing.

The foregoing notice is published in response to many inquiries, to assist those certified by the American Board who are now engaged in correcting their previous listings, or preparing new sketches for the Third Edition of the Directory to be published early in 1945.

Communications should be addressed to the Directory of Medical Specialists, 919 North Michigan Avenue, Chicago 11, Illinois.

## COMMERCIAL EXHIBIT

The Commercial Exhibit, which was a prominent part of the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, held at the Palmer House, Chicago, Illinois, September 24-29, 1944, was an outstanding one both from the point of view of the number of exhibits and general attractiveness of the displays, as well as the various types of equipment shown. Fifty-eight booths were occupied by thirty exhibitors. The exhibits shown included many types of roentgen-ray equipment, and drugs and accessories used by radiologists, radium supplies, and books and journals of interest to radiologists. Intermissions were arranged each day of the meeting to give all those in attendance an opportunity to view the exhibits. At these times the exhibit floor was crowded but at many other times during the day the large number of radiologists seen in the various booths in earnest conversation with the manufacturers' representatives was proof that radiologists welcomed this opportunity for personal contact with the manufacturers after such a lack for two years due to the cancellation of the meetings of both Societies in 1943.

Those having to do with the arrangements of the Joint Meeting of the American Roentgen Ray Society and the Radiological Society are most appreciative of the interest shown by the manufacturers and herewith extend their thanks to those who participated and who added so greatly to the success of the meeting.

The following were represented in the Commercial Exhibit: *AnSCO*, Binghamton, New York; *Buck X-Ograph Company*, St. Louis, Missouri; *Canadian Radium & Uranium Corporation*, New York; *E. I. du Pont de Nemours & Company*, Wilmington, Delaware; *Eastman Kodak Company*, Rochester, New York; *Eureka X-Ray Corporation*, Chicago, Illinois; *General Electric X-Ray Corporation*, Chicago, Illinois; *Kelley-Koett Manufacturing Company*, Covington, Kentucky; *Lea & Febiger*, Philadelphia, Pennsylvania; *Liebel-Flarsheim Company*, Cincinnati, Ohio; *Machlett Laboratories*, Springdale, Connecticut; *F. Mattern Manufacturing Company*, Chicago, Illinois; *Medical Bureau*, Chicago, Illinois; *National Synthetics*, New York, New York; *Newman X-Ray Corporation*, Aurora, Illinois; *North American Philips Company*, New York, New York; *Pako Corporation*, Minneapolis, Minnesota; *Picker X-Ray Corporation*, New York, New York; *Powers X-Ray Products Company*, Glen Cove, New York; *Radiology*, Detroit, Michigan; *Radium Chemical Company*, New York, New York; *Schering Corporation*, Bloomfield,

New Jersey; *Sola Electric Company*, Chicago, Illinois; *Standard X-Ray Company*, Chicago, Illinois; *Charles C Thomas*, Springfield, Illinois; *Victoreen Instrument Company*, Cleveland, Ohio; *Westinghouse Electric & Manufacturing Company*, Pittsburgh, Pennsylvania; *Winthrop Chemical Company*, New York, New York; *Wolf X-Ray Products*, New York, New York; *Year Book Publishers*, Chicago, Illinois.

## NEW OFFICERS

The following officers of the American Roentgen Ray Society were elected for 1944-1945 at an executive session of the Society held during the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America held at the Palmer House, Chicago, Illinois, September 24-29, 1944: *President-elect*: Dr. Ross Golden, New York; *First Vice-President*: Dr. Raymond C. Beeler, Indianapolis; *Second Vice-President*: Commander Harold W. Jacox, M.C., U.S.N.R.; *Secretary*: Dr. H. Dabney Kerr (re-elected), Iowa City, Iowa; *Treasurer*: Dr. J. B. Edwards (re-elected), Leonia, N. J.; *Historian*: Dr. Ramsay Spillman (re-elected), New York; *Chairman of Executive Council*: Dr. J. C. Dickinson, Tampa, Florida; *New Member of the Executive Council*: Dr. Harry M. Weber, Rochester, Minnesota. Dr. Lyell C. Kinney, San Diego, assumed the office of *President*.





## DEPARTMENT OF TECHNIQUE

*Department Editor:* ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.  
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### SIMPLE METHOD FOR STUDY OF THE COLON IN THE PRESENCE OF A COLOSTOMY

By LIEUTENANT COLONEL ROBERT C. PENDERGRASS

*Medical Corps, Army of the United States*

and

CAPTAIN FREDERICK W. COOPER, JR.

*Medical Corps, Army of the United States*

THE generally accepted therapy of performing a colostomy for wounds of the large bowel has brought an increasing number of these cases under observation. The evaluation of the condition of the lower segment of bowel by roentgenographic and sigmoidoscopic examination is difficult unless the stoma of the colostomy is effectively plugged. With injection of barium, the rectum and colon cannot be well distended due to rapid escape of the enema through the colostomy. Not only is unsatisfactory visualization obtained but escape of the barium upon the abdominal wall may mask the outline of the colon. Soiling of the abdominal wall, dressings and roentgen table usually results. Similarly, if the stoma is al-

lowed to remain open, the distal portion of the bowel cannot be distended with air to facilitate sigmoidoscopy.

Rubber bulbs, such as those used in Asepto syringes, may be obtained in a variety of sizes. The neck of the bulb is in-



FIG. 1. Barium enema spilled over abdominal wall. Colostomy open.



FIG. 2. Distal colon well filled. Colostomy plugged.

serted into the colostomy stoma and the bulb strapped down firmly with adhesive prior to roentgenographic or sigmoidoscopic examination.

Figure 1 shows spilling of barium over the abdominal wall without use of the colostomy plug. Figure 2, same patient, shows effective plugging of the colostomy opening by the rubber bulb and a well-filled distal colon. The bullet which perforated the lower bowel is seen overlying the left acetabulum.

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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN DIAGNOSIS

### HEAD

LIST, CARL FELIX, Osteochondromas arising from the base of the skull. *Surg., Gynec. & Obst.*, April, 1943, 76, 480-492.

Intracranial tumors of cartilaginous structure are among the most unusual types of neoplasm encountered by the neurologic surgeon. The osteochondromas arising from the base of the skull exhibit a characteristic anatomical and clinical picture. In view of the rare occurrence of the basal osteochondroma as many observations as possible were utilized in this study. The illustrative case histories which are presented are divided into two groups: (1) primarily intracranial osteochondromas, arising from the sphenoid bone (5 cases), and (2) primarily extracranial osteochondromas of the ethmoidal or sphenoidal region with secondary intracranial extension (2 cases).

#### *Anatomical and Pathogenetic Considerations.*

1. The base of the skull is a preferential location of osteochondromas.
2. The sphenoid and ethmoid are preferential sites of osteochondromas.
3. These lesions develop apparently from cartilaginous rests of the primordial cranium.
4. It is interesting that chordomas are found in a location similar to that of osteochondromas, viz., at the junction of the basisphenoid with the occiput.

#### *Clinical and Diagnostic Considerations.*

1. Incidence and duration of symptoms. These neoplasms usually become clinically manifest in young adults, between the ages of twenty and thirty. Their rate of growth is slow so a clinical course over ten or even twenty years is not unusual.
2. Neurologic symptomatology. The intracranial osteochondroma of the sphenoid produces a characteristic clinical syndrome. As a result of the parasellar location of the lesion, the structures in the wall of the cavernous sinus are affected at an early stage. Primarily extracranial osteochondromas of the ethmoidal or sphenoidal regions produce neurologic signs only in the later phases of the disease.

noidal regions produce neurologic signs only in the later phases of the disease.

3. Roentgenographic signs. The presence of basal osteochondromas is revealed by localized erosion of bone combined with dense calcifications in the tumor. Intracranial sphenoidal osteochondromas produce more or less marked parasellar erosion. Ethmoidal osteochondromas may destroy ethmoidal bones, the floor of the anterior fossa, and the medial wall of the orbit. Calcifications in osteochondromas are either arranged in coarse flakes or they may be so dense as to simulate cancellous bone thus outlining the entire tumor mass.
4. Differential diagnosis: (1) aneurysm of the internal carotid artery; (2) parasellar meningiomas; (3) craniopharyngiomas; (4) chordomas.

*Treatment and Prognosis.* Since osteochondromas do not respond to irradiation, surgical treatment is the only promising form of therapy. Since most intracranial osteochondromas must be removed piecemeal, their extirpation may be incomplete and hence a recurrence is likely to develop eventually. The postoperative period of survival may be a long one unless the neoplasm has sarcomatous propensities.—*Mary Frances Vastine.*

HAWES, LLOYD E., and MEADE, SEDGWICK. Posterior displacement of the calcified pineal in subtentorial brain tumors. *Radiology*, April, 1943, 40, 367-370.

Generally displacement of the calcified pineal gland can be relied on in the localization of brain tumor. If the gland is displaced upward the tumor is beneath it, etc. But the authors have seen 3 cases in which the patients had subtentorial (posterior fossa) tumors but the pineal gland was shifted backward. These cases are described and illustrated with a roentgenogram and a diagram of the ventricular system showing the probable cause of the paradoxical displacement. It is due to an internal hydrocephalus caused by obstruction of the outflow of the spinal fluid through the aqueduct. This results

in distention of the third ventricle which pushes the pineal gland backward.—*Audrey G. Morgan.*

BURROWS, HAROLD, CAVE, A. J. E., and PARBURY, K. Radiographical comparison of the pituitary fossa in male and female whites and Negroes. *Brit. J. Radiol.*, March, 1943, 16, 87-89.

A roentgenological study of 100 pituitary fossae was made under identical conditions so that the results were comparable. The outlines of the fossae in the median sagittal plane were obtained. Fifty of the skulls were from African Negroes from known localities and 50 were skulls of white persons from an old London cemetery. Tables giving details of the results and silhouettes of white and black, male and female fossae are given. The male fossa was found to be larger than the female; in an examination of various animal species the reverse was found to be true. The fossa was larger in the Europeans than in the Africans. There were great individual variations in the size and shape of the fossae. This is probably due to anthropological and racial factors and a further study should be made of the subject.—*Audrey G. Morgan.*

GRIFFIN, ERNEST P., GIANTURCO, CESARE, and GOLDBERG, SOLOMON. A stereoscopic method for the localization of intraorbital foreign bodies. *Radiology*, April, 1943, 40, 371-374.

The usual methods of localization of foreign bodies in the eye are satisfactory in the hands of experts but complicated and difficult for roentgenologists who do not have much practice. A simple method for localizing such foreign bodies is described which can be used by any roentgenologist. The apparatus used is a localizer and a roentgen visible artificial eye. They are described and illustrated. The localizer consists of a base with a vertical mast to which the artificial eye can be fixed. The patient lies prone on the table with his chin slightly raised by a small pillow and a film of the injured eye is made. The patient then slides down from the table and the artificial eye placed in the position of the injured eye. Two stereoscopic films are then taken with low voltage. This gives two stereoscopic films of the orbit and foreign body on which the stereoscopic shadow of the artificial eye will also be cast. After processing, the films are placed in the stereo-

scope and the position of the foreign body determined by direct visual observation.

The artificial eye is made for the average size of the human eyeball; as this varies little the method is very accurate except that caution should be exercised in examining the eyes of children and in conditions which are known to cause changes in the axial length of the eye. A necessary condition to the successful use of the method is the possession of good stereoscopic vision by the roentgenologist and ophthalmologist.—*Audrey G. Morgan.*

#### NECK AND CHEST

ROBINSON, DAVID W., and HARLESS, MORRIS. Papillary cystadenoma lymphomatosum of the parotid gland. *Surg., Gynec. & Obst.*, April, 1943, 76, 449-452.

The authors report 4 cases of papillary cystadenoma lymphomatosum (adenolymphoma or onkocytoma) of the parotid gland, making a total of 71 which have been described in the literature.

This tumor is a well encapsulated structure which occurs in salivary tissue, usually the parotid gland. It has a firm fibrous capsule. The nodular mass is round, oval, coarsely lobulated, or bosselated and is moderately firm but cuts with ease, revealing a cut surface smooth or finely granular with numerous small cystic spaces.

There are multiple theories as to the origin of this tumor. Many consider that the cyst is of branchiogenic origin. Another popular belief is that the lymphoid tissue of the preauricular node blends with a parotid lobule, the resulting mixture being separate from the parotid itself.

Papillary cystadenoma lymphomatosum occurs chiefly in men of the fifth and sixth decades. The tumor involves most often the lower pole of the parotid, is slow growing, and usually painless. It is easy to remove. Recurrence is rare and radiation therapy is of no value.—*Mary Frances Vastine.*

HAIGHT, CAMERON, and TOWSLEY, HARRY A. Congenital atresia of the esophagus with tracheoesophageal fistula. *Surg., Gynec. & Obst.*, June, 1943, 76, 672-688.

The surgically ideal plan for the correction of congenital atresia of the esophagus with tracheo-esophageal fistula is a reconstruction of the continuity of the esophagus by an extra-pleural ligation of the fistula and an end-to-end

anastomosis of the esophageal segments. The first successful case of reconstruction of the esophagus by this plan is presented. The factors pertaining to operative correction of the anomaly and experiences in a series of 15 cases are discussed.

*Roentgenographic Observations concerning Operability.*

1. A liquid radiopaque material is used to determine the level of obstruction of the upper esophageal segment. Iodized oil should be employed instead of a barium suspension as the barium may cause serious pulmonary complications if it gains entrance into the bronchi.

2. The oil is administered under roentgenoscopic control as it is advisable to limit the amount so that it will not overflow into the trachea.

3. At the conclusion of the examination, the retained oil in the upper esophageal segment is aspirated through a catheter.

4. The blind end of the dilated upper esophageal segment is usually found at a level between the first and third dorsal vertebrae. As seen fluoroscopically, the upper esophageal segment is not a fixed structure but undergoes a vertical excursion during respiration.

5. The presence of air in the stomach is indicative of a communication between the trachea and the lower esophageal segment. Although the failure to visualize air in the stomach suggests the absence of a tracheoesophageal fistula, this fact is not necessarily true.—*Mary Frances Vastine.*

### MISCELLANEOUS

PATERSON, EDITH. A comparison of the action of X and gamma rays on fibroblasts. Part II. *Brit. J. Radiol.*, Oct., 1942, 15, 302-306.

Previous work on this problem has shown that when fibroblast cultures were irradiated on glass coverslips there was no qualitative difference in the action of roentgen and gamma rays. There was a quantitative difference. Roentgen rays were found to be more lethal than gamma rays. This article deals with experiments made to determine whether this difference was due to the atomic weight of the silicon in the glass coverslips. Tests were made with coverslips of heavy materials (gold, lead, glass) and light materials (polystyrene derivatives, paraffin). It was found that on all the heavy materials the action of roentgen rays was more

lethal than that of gamma rays but that there was no significant difference in the action of the two kinds of rays on the light materials. It would seem therefore that the action of roentgen rays is influenced by the atomic weight of the material in immediate contact with the cells and that this difference is due to the fact that the heavier substances have a greater secondary emission of electrons.—*Audrey G. Morgan.*

GOODRICH, JAMES P. Experimental modification of radiosensitivity of embryonic cells. *Radiology*, Feb., 1943, 40, 179-187.

Experiments in modifying the radiosensitivity of the eggs of the grasshopper by temperature and dehydration were made at the State University of Iowa, Iowa City. The method of the experiments is described and graphs given showing the details of the results.

These eggs when kept at a constant temperature of 25° C. develop for approximately twenty-one days (prediapause period) at the end of which time they enter a period of developmental block (diapause). If they are then placed at a low temperature (10° C.) for two to three months, on return to a temperature of 25° C. they will undergo further development (postdiapause) and hatch about the eighteenth day. The effect of low temperature was to decrease sensitivity before the third day of prediapause development and to increase it during the remainder of prediapause and the first two days of postdiapause. Dehydration caused an increase in sensitivity before the fifth day of prediapause and a decrease during the remainder of prediapause and on the second day postdiapause.

So far as is known the only common effects of low temperature and dehydration are inhibition of development and reduction in rate of oxygen consumption. These effects are evidently due to a specific action of temperature and dehydration on the cells and it is obvious from the different effects of the two agents that they do not act in the same way. It is possible that low temperature changes the oxidative mechanisms while dehydration may cause changes in the osmotic relations of the cells to the fluids in which they are bathed.

The present experiments show that radiosensitivity of cells may be changed in opposite directions by the same agent at different stages of their development. Further experiments along this line should yield greater understand-

ing of the processes involved in the radiosensitivity of cells.—*Audrey G. Morgan.*

GRAY, L. H., and READ, JOHN. The effect of ionizing radiations on the broad bean root. Part IV. The lethal effect of alpha radiations. *Brit. J. Radiol.*, Nov., 1942, 15, 320-336.

This is a continuation of a series of investigations of the effect of different kinds of radiation on the broad bean root. The method of experiment is described and the mathematical formulae used in the calculations given, together with graphs and tables showing the details of the results.

The bean roots were immersed in water containing dissolved radon. Two minutes after immersion half the equilibrium value is reached. At equilibrium the concentration of radon in the bean root is the same as that in the surrounding solution. The radon atoms show a marked tendency to accumulate on the surface of the root.

It was found that alpha radiation is about as effective as neutron radiation in killing the broad bean root and about 9 times as effective as gamma radiation.—*Audrey G. Morgan.*

BISGARD, J. DEWEY, HUNT, HOWARD B., NEELY, ORVIS A., and SCOTT, PAUL. Experimental studies of the mechanism of action of x-ray therapy upon infection. *Radiology*, Dec., 1942, 39, 691-696.

The authors report experiments on rabbits which show that roentgen irradiation brings about a large reduction in the mortality from toxemia of bacterial origin and that this effect is apparently produced by the liberation of an antitoxic factor. Rabbits were infected with *Escherichia coli* of low virulence so that large doses had to be given. Irradiation after inoculation had no effect, as all the animals died within five hours as did the controls. But when irradiation was given at intervals before inoculation varying from sixteen weeks to twenty-four hours it was found that a considerable degree of protection against an otherwise lethal culture was provided. The protective factor was present in twenty-four hours, reached its maximum at forty-eight hours and had completely disappeared in seven days as there were no survivors among the animals irradiated more than seven days before inoculation.

Injection of peritoneal fluid from the irradiated animals into other rabbits protected them

from peritonitis and the blood serum also had this protective action, indicating that the antitoxic factor resulting from irradiation was present in the blood. It may be that protective substances are liberated by breaking down of leukocytes.

The cultures used contained a lethal dose of toxin at the time of injection so that the production of further toxin by growth of the bacteria in the peritoneal cavity was not necessary to cause death. This explains the failure of sulfa drugs in these cases as they are only bacteriostatic agents.

In the discussion Dr. Kelly said that he hoped the work of Dr. Bisgard would reduce the use of extensive debridement and amputation during the acute toxic stage of gas gangrene and give place to the use of roentgen treatment. It is the toxemia that kills and not the local disease. As roentgen rays affect toxemia and the sulfa drugs do not it is evident that the former is to be preferred.

Dr. Lockwood disagreed with the conclusion that this work proved the value of the routine use of roentgen therapy in the treatment of established infections. He said Dr. Bisgard's experimental lesions were quite different from an established invasive infection.—*Audrey G. Morgan.*

EVANS, T. C., SLAUGHTER, J. C., LITTLE, E. P., and FAILLA, G. Influence of the medium on radiation injury of sperm. *Radiology*, Dec., 1942, 39, 663-680.

Experiments in the irradiation of sperm of the sea urchin (*Arbacia punctata*) and the marine worm *Nereis* are described and tables and graphs given showing the influence of dosage, time and the medium on the injury done to the sperm. As the dosage of radiation is increased fewer sperm in a suspension are capable of fertilizing eggs. This change takes place immediately after irradiation. Also with the lapse of time the number of sperm capable of fertilizing eggs decreases. Also sperm irradiated in the seminal fluid are very resistant to irradiation while with increasing dilution with sea water the radiosensitivity increases, though it has not been proved that the increase in radiosensitivity is proportional to the amount of dilution.

It was found that when *Nereis* sperm and *Arbacia* sperm were mixed each seemed to afford a certain degree of protection to the other

against the action of irradiation. Protection was also afforded by the addition of "egg water," the supernatant fluid from the jelly surrounding the *Arbacia* egg; also by egg albumin, gelatine, gum arabic, glycyl-glycine and glycine.

Both the effect of the dilution and the protective action of these substances may be explained on the assumption that irradiation acts indirectly on the sperm through the influence of activated water molecules. The protective substances protect by deflecting the action of these activated water molecules from the sperm to the substances in question. Experiments seemed to show that the hydrogen peroxide produced in irradiated water had little effect on the inhibition of the fertilizing capacity of the sperm. But another effect of irradiation, namely the delay in cleavage time of the eggs fertilized with the irradiated sperm seems to be caused directly by the action of the irradiation on the sperm. Obviously, therefore, it makes a difference in considering damage caused by radiation what effect of the radiation is taken as a measure of the damage.—*Audrey G. Morgan.*

RIGOS, FRANK J. Roentgenologic irradiation in acute peritonitis and its effect on the cells of the normal peritoneal fluid in guinea-pigs. *Radiology*, Dec., 1942, 39, 681-690.

In the experiments described in this article peritonitis was induced in guinea pigs by the introduction of colon bacilli or non-hemolytic streptococci. The animals were then treated by irradiation with the following factors: 100 kv., 5 ma., 2 mm. aluminum filter, 20 inches (51 cm.) distance, portal 10×7 cm., air dose 15 r per minute, half-value layer 3 mm. aluminum. Various doses were given. It was found that doses of less than 100 r had little effect on the total cell count of the peritoneal fluid but that they did cause a relative increase in the percentage of macrophages and lymphocytes. Doses of 100 r or more caused an increase in the total cell count. Doses of 200 r or more caused a decrease in the total count with a relative increase in the percentage of macrophages. The macrophage as well as the heterophilic leukocyte is capable of phagocytizing bacteria. It would seem that macrophages appear not as a response to bacterial invasion per se but rather as a result of the action of the heterophils which are the body's first line of defense against invading bacteria.

In these experiments doses of from 50 to 100 r had an irritant effect on the peritoneal fluid; doses of less than 50 r did not have any apparent effect on the cell count, and doses of more than 100 r had an immediate destructive action. Therefore it would appear that doses of 50 to 100 r with their irritant action on the peritoneal fluid may be of value in the treatment of peritonitis in the guinea pig.—*Audrey G. Morgan.*

MAYNEORD, W. V. What may we expect from physics? *Brit. J. Radiol.*, Oct., 1942, 15, 286-288.

Closer collaboration between radiologist and physicist is to be hoped for and expected in the future. Generally the physicist is supposed to be concerned chiefly with therapeutic radiology but his collaboration in diagnostic radiology is just as important. And entirely beyond the practical problems of diagnosis and treatment he should be concerned with fundamental biological knowledge rather than mere technical advancement.

There should be a full-time physicist on the staff of every center of diagnostic and therapeutic radiology. He should work side by side with the radiologist in the clinic and become acquainted with the actual bedside problems of the latter. There is a great deal of routine work to be done but the young physicist should have about half his time for study and research, otherwise he will be discouraged from joining the radiological staff but will prefer working in the university. He should also do some teaching work and help to bring the student into contact with the field of physics applied to medicine. At present there is too little contact between academic physics and radiological departments and the staff physicist should broaden and deepen the contact and understanding between them. Doubtless there will be great advances in the future in both technical accomplishment and fundamental biological knowledge brought about by closer collaboration of physicist and radiologist.—*Audrey G. Morgan.*

FARMER, F. T. Considerations in the measurement of x rays for deep therapy. *Brit. J. Radiol.*, July, 1942, 15, 203-208.

All the methods of measurement discussed in this article depend on the ionization of air by roentgen rays and indicate the dosage in roentgens. The mekapiion or Hammer type of



dosimeter has proved of practical value but in applying this instrument to the measurement of the skin dose there is a small space between the skin of the patient and the center of the chamber. This separation, which varies with the manner of applying the instrument, causes some inaccuracy in the measurement. Tube output calibration is reliable if the output of the tube remains constant but tube output may vary considerably in the course of a few minutes and in that case dosage determination by this method becomes unreliable. A fixed chamber integrating dosimeter is described, by the use of which the inaccuracies of the two methods mentioned above may be avoided. The chamber is fixed in the output aperture of the tube. There is an integrating mechanism similar to that of the mekapion on the operator's desk so it is not necessary to place an instrument at the base of the applicator. This arrangement has been found satisfactory as far as physical performance is concerned but its clinical usefulness will have to be tested further.—*Audrey G. Morgan.*

KOCH, H. W., KERST, D. W., and MORRISON, P. Experimental depth dose for 5, 10, 15 and 20-million-volt x-rays. *Radiology*, Feb., 1943, 40, 120-127.

This is a technical discussion of the experimental depth dose for 5, 10, 15 and 20 million volt roentgen rays illustrated with curves showing the experimental results. It is particularly concerned with the 20 million volt electron beam now produced by the University of Illinois betatron. The best way to use the betatron in treatment would be to send the original electrons, accelerated in the vacuum tube, directly into the patient. At 20 million volts they will penetrate 10 cm. and no farther so that no damage is done to the back of the patient. Though a sufficiently intense beam of electrons now comes from the betatron it is not yet in a good enough state of collimation or control for practical use.

The chief characteristics of the high energy depth dose curves are: that the point of maximum dose is as deep as 3 or 4 cm. below the surface of the phantom and that this maximum can be several times greater than the surface dose. Roentgen rays in this energy range, therefore, will pass not only through the skin but

also through the subcutaneous fat without causing much damage while a larger dose will act on the deeper tissues. The region to be treated can be placed near the point of maximum intensity of ionization by compression of the patient's body and cross-fire will be less important.—*Audrey G. Morgan.*

CRAGGS, J. D., and SMEE, J. F. Geiger-Müller counters. *Brit. J. Radiol.*, Aug., 1942, 15, 228-232.

This is a technical description of the properties and uses of Geiger-Müller tube counters, illustrated with tables and curves. The technique of making and using the counters is discussed only briefly as many other articles have been written on the subject but the counting mechanism and technique of operation are given in detail. There is some error in the counts caused by the limited resolving power of the Geiger-Müller counter and associated circuits.—*Audrey G. Morgan.*

KERST, D. W. The betatron. *Radiology*, Feb., 1943, 40, 115-119.

The word betatron means an agency for producing high energy electrons and it has been applied to a magnetic induction accelerator which has been constructed at the University of Illinois. It is probable that the most useful application of the betatron will be the production of high-speed electrons or beta rays.

This apparatus introduces a new method of electron acceleration. Energy is transferred to the electrons by the accelerating action of a time-varying magnetic field. As the betatron is a powerful magnet between the poles of which the electrons circulate in essentially one plane, it looks something like a small cyclotron but it can accelerate particles whose velocity is very nearly as great as that of light, while the cyclotron can accelerate only much heavier particles with a much lower velocity.

Diagrams of the betatron are given and its action described in detail. While the 20 million volt apparatus already constructed at the University of Illinois will probably prove useful in therapy the 100 million volt apparatus that has been designed will probably be used in certain cosmic ray work being carried on in the laboratory.—*Audrey G. Morgan.*

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## DILATATION OF THE VERTEBRAL CANAL ASSOCIATED WITH CONGENITAL ANOMALIES OF THE SPINAL CORD

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### INTRODUCTION

THAT the spinal canal may be markedly dilated as the result of an intraspinal neoplasm is well known, but that an equally pronounced dilatation may occur at any level as the result of a congenital anomaly of the cord structures is not generally recognized. The present report concerns 3 cases of dilatation of the spinal canal associated with myelodysplasia, and a fourth case with a vascular anomaly of the spinal cord.

### CASE REPORTS

*CASE 1. Male, aged twenty-five, complaining of a deformed left leg, paresthesias in saddle region, and urinary incontinence: atrophic left leg, bilateral sacral hypesthesia and neurogenic bladder; dilatation of sacral canal demonstrated by roentgenograms and at operation with lipoma of conus medullaris adherent to coccyx: marked improvement after removal of lipoma.*

J. S. (Unit No. 218520), a steel worker, aged twenty-five, was referred to the neurosurgical service by Dr. Charles Huggins on May 22, 1939. At the age of seven, the patient injured the left foot following which he noticed that the left leg was weaker than the right. Eight or nine years before admission a numbness developed over both buttocks. In the summer of 1936 he was first troubled with enuresis and

urinary frequency. This progressed so that during the few months prior to admission he had to use a rubber condom at night. He experienced an urgent desire to micturate every two to three hours during the day.

On physical examination the patient appeared to be well developed except for the lower extremities. The heart and lungs presented no abnormalities. His blood pressure was 122/64. The left thigh was definitely smaller than the right, measuring 42 cm. in circumference, 15 cm. above the patella, as compared to 49 cm. on the right. The right leg, 15 cm. below the patella, was 33 cm. in circumference and the left 23 cm. The right knee and ankle jerks were livelier than those on the left. The plantar reflexes were flexor. In the saddle region below the fifth lumbar segment the appreciation of pain was impaired although the patient was able to distinguish between the head and the point of a pin. After voluntary micturition there was between 240 and 400 cc. of residual urine. Blood examinations including the Wassermann test were normal. Repeated urinalyses showed no abnormality other than the presence of numerous white blood corpuscles. A cystometrogram was interpreted as indicating a hypertonic bladder.

A lumbar puncture was performed. The initial pressure was 160 mm. of spinal fluid and the dynamics were normal. The fluid was clear and colorless. The Wassermann test was nega-



FIG. 1. Case 1. Roentgenogram of the lumbosacral spine showing the enlargement of the spinal canal in the sacral region and the spina bifida occulta of the first sacral vertebra. The interpedicular distances measured: thoracic 10, 21 mm.; 11, 21 mm.; 12, 23 mm.; lumbar 1, 27 mm.; 2, 28 mm.; 3, 29 mm.; 4, 31 mm.; 5, 33 mm.; and sacral 1, 42 mm.

tive and the Lange curve was 0000000000. The total protein of the spinal fluid was 39 mg. per 100 cc. Roentgenograms of the abdomen and pelvis revealed no abnormality in the soft tissue but an incomplete fusion of the laminae of the first sacral vertebra (Fig. 1). Cystograms showed marked trabeculation of the bladder and reflux filling of the right ureter. A pneumomyelogram was made which revealed a marked enlargement of the sacral sac. The history and findings suggested that the patient had a congenital abnormality of the lower part of the spinal cord.

On May 29, 1939, the patient was anesthetized with ether and a laminectomy performed in the lower sacral region. A midline incision was carried from the third lumbar spine to the lower border of the first sacral spine. The paravertebral muscles were separated by subperiosteal dissection from the spines, which were then removed. The laminae of the fourth and fifth lumbar and the first sacral vertebrae were then rongeur'd away. The dural sac appeared abnormally wide. When incised and the dural margins separated, the spinal cord was seen to pass down the center of the canal. The arachnoid over this was definitely milky and in places adherent to the dura mater. After lengthening the skin incision, the spines and laminae of the sacral vertebrae were removed. This exposed an enormous dilatation of the inferior portion of the spinal canal. It measured 4 cm. in width and was about 4 cm. anteroposteriorly. The spinal cord was seen to pass down the middle of this enlarged canal and terminate to the left of a mass of fatty tissue which was adherent to the end of the sacral sac. The lipomatous mass measured 2 cm. in diameter and from it numerous connective tissue trabeculae passed to the tip of the sacral sac. The roots of the sacral nerves passed from the spinal cord asymmetrically and ran slightly caudad or cephalad to the intervertebral foramina. The lowest roots on each side appeared to pass from the anterior surface of the fatty mass and enter the sacral foramina. The fatty mass was dissected and removed piecemeal to avoid damage to nerve fibers passing through it. The numerous fibrous bands attached to the dura were finally broken and the spinal cord allowed to retract in the spinal canal. This released the tension on the lower sacral roots. Each time the fatty mass was grasped with the tissue forceps the spinal cord was seen to tighten spasmodically and then relax. This twitching was seen several times and was considered to be due to the presence of muscle fibers in the lipoma or in its attachment to the dura. After careful scrutiny for bleeding points, the dura mater was sutured and the muscles and skin were closed in anatomical layers (Fig. 2).

*Pathology Report.* Sections of the tissue removed at operation showed it to be composed chiefly of large fat cells in a connective tissue stroma.

The patient had an uneventful convalescence although he required an indwelling catheter for almost two weeks after operation. The residual

urine decreased to 30 cc. but still contained many pus cells. On June 16 he was discharged from the hospital. The wound had healed *per primam*.

He was seen on several occasions following his discharge, the last one being November 17, 1939. He stated that he felt fine, was working regularly and had incontinence only occasionally while at work and never at night. The motor and sensory status of his lower extremities was essentially the same as preoperatively. The patient considered himself very markedly improved.

*Comment.* The caudal portion of the spinal cord is the usual part to be involved by anomalies. A diffuse lipoma infiltrating the roots of the cauda equina and extending through the laminae to the subcutaneous tissues presenting a mass over the sacrum covered by hairy skin is commonly seen associated with spina bifida occulta. The myelodysplastic condition seen in the present case, consisting of a single trunk from which the lumbar and sacral nerves are given off, instead of a cauda equina, is less frequently encountered. The trunk may be the site of various pathological processes such as lipomata, dermoid cysts, or adhesive bands<sup>16</sup> which may or may not be connected anatomically to the defect in the spinal lamina. The sacral canal is usually but not necessarily dilated.<sup>21</sup> A severe myelodysplasia may be present without dilatation of the sacral canal and with a normal appearing cauda equina.

The history of the present case is typical of myelodysplasia associated with spina bifida occulta. A mild impairment of function in one lower extremity noticed in early life followed by urinary disturbances beginning in adolescence and increasing in severity in early adult life is the story frequently given by patients with this disorder. The late occurrence of symptoms is probably related to the tension placed upon the spinal cord by the greater growth of the vertebral column. The relief of symptoms obtained by sectioning the adhesions binding the conus medullaris to the sacral sac seems to support this hypothesis.

**CASE II.** *Male, aged thirteen months, suffering from a weak right leg since birth; spastic atrophic right leg with absent tendon reflexes; no sensory disturbance; enlarged lumbar spinal canal by roentgenography; marked myelodysplasia at operation.*

E. B. (Unit No. 284522), male, aged thirteen months, was referred to the neurosurgical service by Dr. Howard Hatcher on June 17, 1942.

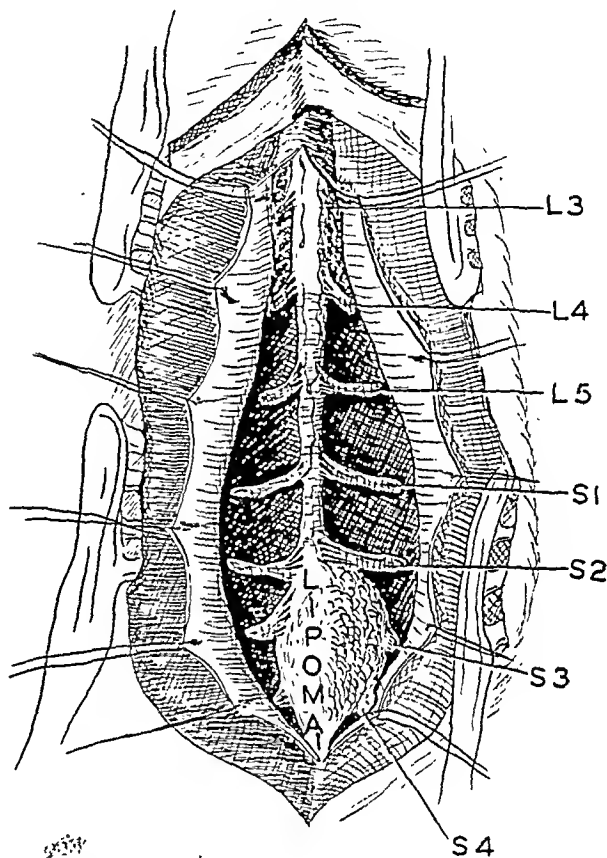


FIG. 2. Case 1. Sketch of operative field to show the appearance of the caudal sac and its contents. The irregular spacing of the sacral roots which come off at right angles from the elongated conus medullaris is evident.

The parents had noted shortly after his birth that the baby did not move the right leg well. The limb seemed rather flabby and limp. The right foot appeared smaller than the left. When the child started to crawl, some improvement was noted but when he attempted to stand the right foot was everted. The birth history was not unusual, in fact his mother believed that the delivery was normal. Except for the presenting complaint his development was normal.

On physical examination the patient appeared to be a well nourished baby of about one year. The chest and abdomen presented no abnormality. The cranial nerves functioned well

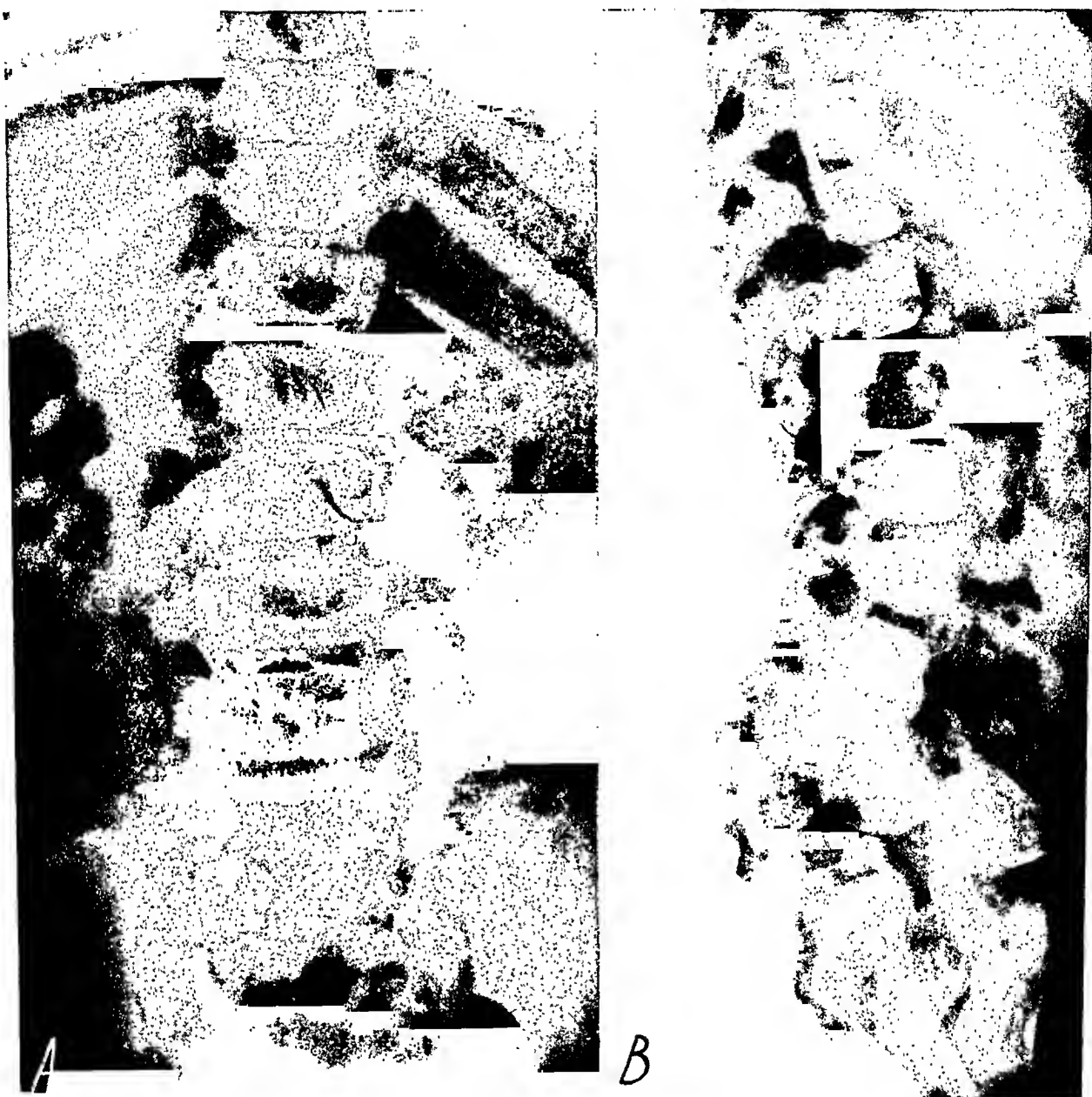


FIG. 3. Case 11. Roentgenograms of the lumbosacral spine showing the marked dilatation of the spinal canal, and the anomalies of the laminae of the lumbar vertebrae. *A*, anteroposterior view; *B*, lateral view. The interpedicular distances measured: thoracic 6-11, 15 mm.; 12, 16 mm.; lumbar 1, 17 mm.; 2, 23 mm.; 3 and 4, 24 mm.; 5, 23 mm.; and sacral 1, 24 mm.; 2, 17 mm.

and the upper extremities were well developed and strong. The right leg was shorter and smaller than the left. The right calf measured 6 cm. in circumference and the left 6.5 cm. The right leg was spastic to passive manipulation but its tendon reflexes could not be obtained. The left leg had normal tone on passive manipulation although the left knee and ankle jerks were hyperactive. The left leg was moved freely at all joints. The right hip and knee could be flexed and extended fairly well but the right ankle could be moved very little. Sensation

could not be accurately determined but no severe defect appeared to exist.

Roentgenograms of the lumbar spine revealed a marked increase in the width and depth of the spinal canal in the upper lumbar region. The right pedicle of the second lumbar vertebra was very thin and small. Its inferior half appeared to be missing. The laminae of the lower lumbar vertebrae were not fused (Fig. 3).

Examinations of the blood and urine revealed no abnormalities. The child was thought to have a congenital cyst of the spinal cord.

On June 18, 1942, the patient was anesthetized with ether and the lumbar region explored. A midline incision was made over the spines of the lumbar vertebrae and the muscles were then separated by subperiosteal dissection from both sides of the spines. The spines were very short and the laminae came off the spines almost immediately. The spines and laminae were rongeur'd away on both sides. There was little epidural fat and the spinal canal was unduly wide. The dura mater was incised longitudinally exposing the arachnoid and spinal cord (Fig. 4). The spinal cord was split into two cords, a larger one on the left side from which the nerve roots came off quite normally. On the right side, however, the nerve roots were irregularly spaced and came off of a smaller cord of tissue at right angles. A strand from the larger cord joined the smaller at approximately the level of the lower border of the third lumbar vertebra and a second bridge crossed just below this point. Below this level the two spinal cords were again fused. Since no surgical procedure was indicated, the dura mater was closed and the muscles approximated.

The patient had an uneventful convalescence and was discharged on June 28, 1942. He returned to the clinic on July 27, at which time the parents stated that his condition had changed very little. He was able to stand and take a few steps. The wound was well healed. The tendon reflexes were absent in the right but quite active in the left leg.

*Comment.* This case illustrates a dilatation of the spinal canal due to a diplomyelia or more probably a diastematomyelia. The neurological disturbances are probably the result of the myelodysplasia rather than being due to the fixation of the spinal cord abnormally low in the spinal canal.

The severe forms of myelodysplasia resulting in a doubling or splitting of the spinal cord have been usually a concomitant of an extensive spina bifida with meningocele, meningomyelocele or myelocele.<sup>5,6,22</sup> In those cases in which the vertebral canal has been well formed in the presence of diplomyelia or diastematomyelia, a dilatation of the canal has usually been present with or without a rudimentary division of the canal. Herren and Edwards<sup>13</sup> state that the spinal canal may

show an abnormal appearance varying from a moderate degree of dilatation at the level of the duplication of the cord to partial doubling. In about one quarter of the cases they reviewed, osseous or cartilaginous processes were reported protruding

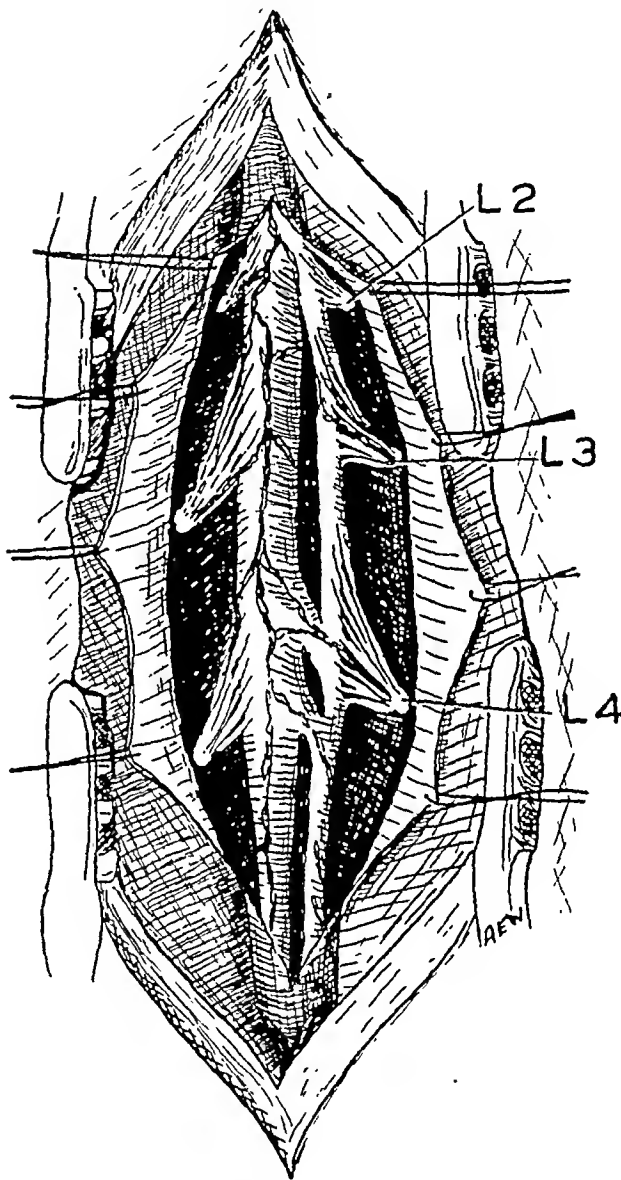


FIG. 4. Case II. Sketch of operative field to show the splitting of the spinal cord and other anomalies.

from the dorsal surface of one or more vertebral bodies, partially dividing the spinal canal in two parts.

*CASE III.* Girl, aged four, following a fall developed a stiff painful neck and progressive weakness of the arms and legs; head traction gave some relief; marked dilatation of the cervical spinal canal; operation revealed a hydromyelia and diastematomyelia; autopsy.





FIG. 5. Case III. Anteroposterior roentgenograms of the cervicothoracic spine showing the marked dilatation of the lower cervical and upper thoracic part of the spinal canal. The interpedicular distances measured: cervical 2, 28 mm.; 3 and 4, 29 mm.; 5, 31 mm.; 6, 34 mm.; 7, 37 mm.; thoracic 1, 39 mm.; 2, 35 mm.; 3, 29 mm.; 4, 26 mm.; 5, 22 mm.

M. L. M.,\* a girl aged four and one-half, was admitted to the Bobs Roberts Hospital on November 27, 1937. Three months previously she had fallen, following which she developed a stiff and painful neck. She was suspected of having acute anterior poliomyelitis and sent to the Municipal Contagious Hospital where the diagnosis was not confirmed and the child sent home. She was symptomless for three weeks and then began to suffer headaches and vomited several times. After one week of these symptoms she was again sent to the contagious hospital. She was found to have weakness of both arms and legs, and a tendency to hold the head stiffly to the left side. A spinal puncture

was said to have shown no abnormality in the spinal fluid. After two weeks she was transferred to the Children's Memorial Hospital where she was seen by Dr. Douglas N. Buchanan. Dr. Buchanan noted rotation of the head so that the chin rested on the right shoulder, gross weakness of both arms, more on the right side than on the left and more marked in the upper arm than in the lower, absence of all tendon reflexes, extensor plantar reflexes and a sensory level at the fourth cervical dermatome for pin prick. The patient was placed in head traction with relief of pain. A spinal puncture showed the fluid to be under normal pressure, and a good rise was obtained on jugular compression. There were three cells per cubic millimeter of spinal fluid and the Wassermann test on the fluid was negative. The tuberculin reaction was negative.

On November 4 the traction was removed but the patient's condition became worse. The child failed to improve and was transferred to Bobs Roberts Hospital for operation.

At the time of admission the child appeared acutely ill, although the heart, lungs and abdomen were not abnormal to the usual methods of examination. There was a complete motor and sensory paralysis below the second cervical dermatome. All deep tendon and abdominal reflexes were absent. The plantar reflexes were extensor. There was a marked vasodilatation of the capillary bed of the hand but the palms were red and mottled. Crutchfield tongs were applied the day of admission following which the patient appeared to be much more comfortable. The following day a lumbar puncture was performed. The initial pressure was 230 mm. of spinal fluid and there was a good rise on jugular compression. Four cells were present per cubic millimeter of spinal fluid and Pandy's test was negative.

Roentgenograms of the cervical spine showed a marked dilatation of the spinal canal from as high as could be seen to the fifth thoracic vertebra. The dilatation was widest at about the first thoracic vertebra where the canal measured approximately 4 cm. in width (Fig. 5):

On December 2, 1937 the patient was anesthetized with ether. With a preoperative diagnosis of congenital tumor of the spinal cord, a cervical laminectomy was performed by Dr. Paul C. Bucy. A midline incision was made from the suboccipital region down to the fifth thoracic spine. The arch of the atlas, spine and laminae of the second cervical vertebra ap-

\* This case was reported briefly by Dr. Paul C. Bucy before the Chicago Pathological Society (Bucy, P. C. Gross congenital malformation of the spinal cord in a child five years of age. *Proc. Inst. Med., Chicago*, 1938, 12, 81).



peared to be normal. From that point downward, however, to the fourth thoracic spine, the vertebrae had no spinous processes and the laminae failed to unite at the midline. The small defect between the ends of the laminae was bridged with fibrous tissue. From above downward and from the fourth thoracic vertebra upward, the laminae grew progressively longer until they were longest and the spinal canal accordingly widest at the level of the seventh cervical and first thoracic vertebra. The entire cervical and upper four thoracic laminae were resected. The dura mater was under considerable tension and did not pulsate until the arch of the atlas was removed. It presented a fusiform swelling conforming to the configuration of the spinal canal. The dura mater was incised longitudinally in the midline. It was very adherent to the underlying arachnoid membrane to which it was connected by numerous threadlike fibrous bands. At one point two large veins united at the midline on either side and passed from the arachnoid backward to the dura mater. Beneath the arachnoid could be seen a large collection of fluid extending into the caudal half of the exposed field where the arachnoid passed over and was in intimate contact with a much dilated spinal cord. In the upper half of the exposed field the spinal cord could not be seen. The arachnoid was incised at the midline. It contained many small vessels which were cauterized. On incising the arachnoid a large cystic cavity presented which did not appear to communicate with the subarachnoid space. This cavity extended from the base of the skull to the caudal limits of the exposed field measuring 8 cm. in length and 3 cm. in width. It was divided into two parts. In the upper half it consisted of a cavity closed on its posterolateral surface by a membrane which appeared to be the arachnoid.

The anterior wall of the cavity in this region was formed by very much flattened spinal cord covered with numerous brownish tufts of choroid plexus. In the middle of the exposed field the spinal cord was seen to split in half, each half migrating to the sides of the spinal canal leaving a cavity between the two halves. Caudally the two parts of the spinal cord reunited at the level of the fifth thoracic vertebra to form a single spinal cord. The cavity was continued into the central canal of the spinal cord for an indeterminate distance. The fluid in the cavity and in the subarachnoid space appeared to be identical. The arachnoid-like tissue form-

ing the roof and the lateral walls of the cystic cavity was resected, opening a communication between the cavity and the subarachnoid space. The choroid plexus was not disturbed because its blood supply seemed identical with that of the spinal cord. The wound was carefully dried, the dura sutured, the bone fragments were laid along the margins of the laminae and the muscles and fascia were closed with two layers of deknatel and the subcutaneous tissues of the skin with two layers of interrupted silk.

The tissue removed from the wall of the cyst at the time of operation was composed primarily of connective tissue similar to that seen in the leptomeninges but was markedly thickened, very vascular and quite cellular. Numerous small blood vessels were present with many polymorphonuclear leukocytes in the vessels. On the inner surface of the tissue were ependymal-like cells and in some places blood vessels lined with cells characteristic of choroid plexus.

The patient did poorly after operation, however, and died approximately twelve hours later. Permission for autopsy was given and was carried out at 5:45 A.M. by Dr. W. A. Stryker. The diagnoses were bilateral pulmonary hyperemia and edema, hyperplasia of the mesenteric lymph nodes, aberrant pancreatic nodules and degeneration of the liver, kidney and myocardium and hydromyelia and myelodysplasia.

#### *Examination of the Central Nervous System.*

*Gross:* Beneath the dura mater was a large cyst enclosed by an arachnoid-like membrane. This cyst was separate from the subarachnoid space. From the level of the first cervical to the fifth cervical vertebra the cyst lay posterior to the spinal cord which was flattened and formed its anterior wall. On the dorsal surface of the spinal cord at this level were many brown papillomatous structures, grossly considered to be masses of choroid plexus. At the level of the sixth cervical vertebra the dorsal surface of the spinal cord split leaving a large opening through which the cystic cavity passed. At this level the spinal cord consisted of two large lateral masses which surrounded the cystic cavity and were united anteriorly by a thin sheet of tissue. At about the level of the fourth thoracic vertebra the two halves of the spinal cord united again, leaving a hydromyelic cavity in the center of the cord (Fig. 6).

*Microscopic:* Sections taken at fairly uniform intervals from the spinal cord and stained by Nissl's and Weil's methods and hemotoxy-

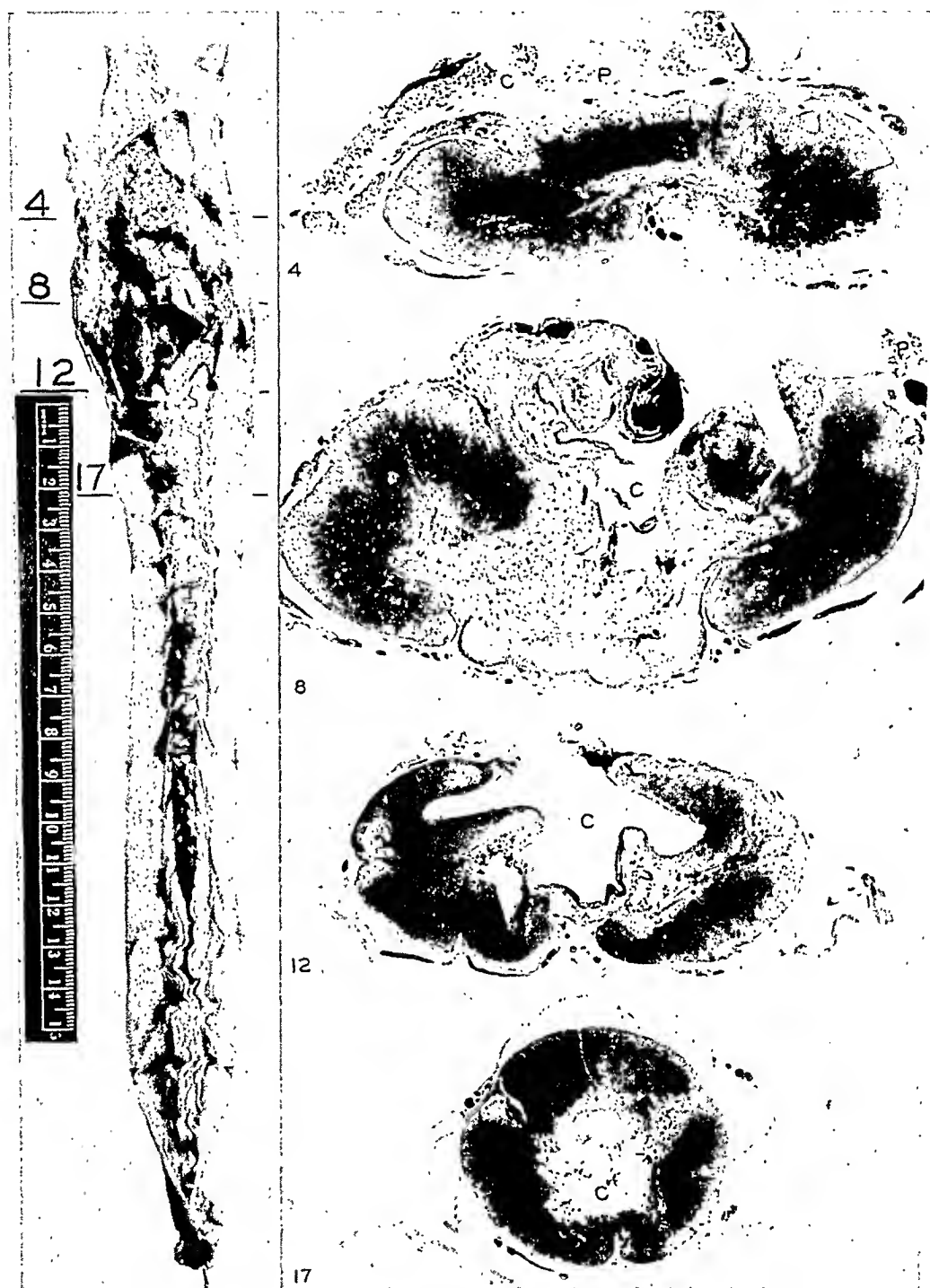


FIG. 6. Case III. Photograph of the spinal cord (dorsal surface) showing the anomaly in the cervical region (left) and photomicrographs of four sections of the maldeveloped spinal cord at different levels. The lines at the sides of the spinal cord indicate the site of the four sections from above downward respectively. C, cyst; P, choroid plexus.

lin and eosin show that the malformation consisted of a cystic posterior dilatation of the central canal of the spinal cord in the cervical region with the formation of a cavity in which choroid plexus was differentiated. In the lower portion of the spinal cord the central canal was well formed, slightly dilated and filled with

debris. In the upper thoracic regions, its structure was broken up and only fragments of the walls were present. The central gray matter was likewise disintegrated, although the anterior horn cells were readily distinguished on each side. Slightly higher the destruction of the central gray matter was more prominent and

apparently traumatic for considerable blood was present. The dilated central canal could not be distinguished although fragments of ependymal columns were scattered about. Slightly higher the disintegrated central area reached the surface posteriorly. Above this level the walls of the posterior surface of the spinal cord were fragmentarily covered with cuboidal ependymal-like cells. These seemed to join with the central canal which at this level split in two. Higher the cavity lost its continuity with the central canal, becoming more and more peripherally situated and containing tufts of choroid plexus arising from the cuboidal lining. Two anterior fissures were present at this level on either side of which were anterior horn cells and between which lay a mass of nerve fibers (anterior commissure). In the upper cervical region the normal anatomical structure of the spinal cord was reformed, but lying on its dorsal surface adherent to the arachnoid was the cuboidal lining of the cystic cavity and a few fragments of choroid plexus. Above the level of the cyst the spinal cord appeared practically normal (Fig. 6).

*Comment.* Splitting of the spinal cord in the cervical region is rare; only two examples in this region are reported and neither lived after birth.<sup>1,11</sup> The great majority of such cases occur below the mid-thoracic region. The essential difference between the present case and those occurring in the lower portion of the spinal axis is the presence of choroid plexus in the cystic cavity. In many other respects this anomaly resembles the malformation described by Weil and Matthews.<sup>20</sup> The inclusion of choroid plexus presumably indicates that the dysraphism involved anlage of structures taking part in the formation of the fourth ventricle.

*CASE IV. Male, aged fifteen, stricken with abdominal pain; previous history of deformity of left foot diagnosed anterior poliomyelitis, followed by urinary incontinence; marked atrophy of legs with absent tendon reflexes; bloody spinal fluid; marked widening of lower thoracic and lumbar spinal canal; angioma and aneurysm of spinal cord at operation; slow recovery.*

F. K. (Unit No. 276616), male, aged fifteen, was referred to the neurosurgical service by Dr. Howard Hatcher on December 25, 1941.

His mother stated that he seemed well until the previous evening when she found him crying with abdominal pain. He stated that he had been suddenly stricken with pain in his side, had fainted, and fallen to the floor striking his head. The boy was able to walk and talk coherently to his mother. He vomited at supper that evening and refused everything by mouth on the next day.

The patient was a full term baby, delivered normally, who developed well until about the age of seven or eight years when he began to walk with a peculiar gait. His left foot rotated inwardly and he slowly developed a valgus deformity of the left foot. Although the onset of this trouble was not acute, it was diagnosed as an anterior poliomyelitis and was treated with casts and later by a tendon-splitting operation. At about the same time the patient developed enuresis and urinary incontinence so that he was seldom continent for more than two or three days at a time. On August 22, 1941, his urine was bloody and remained so for several weeks. From that time he became weaker, paler and lost weight.

At the time of admission he was irritable, lethargic and exhibited generalized muscular rigidity. On examination he had an obvious squint which was congenital. His blood pressure was 130/80 and there were no abnormalities in the cranial nerves. The heart and lungs appeared normal. The urinary bladder was markedly distended and the abdomen was quite rigid. The left leg was thin and wasted. There was a bilateral clawfoot, the left more marked than the right. The legs were spastic but the strength was fairly good. There was a sensory level with relative hypalgesia below the twelfth dorsal segment. The tendon reflexes in the lower extremity were absent. The left plantar response was extensor. The neck was retracted and Kernig's and Lasègue's signs were positive.

Roentgenograms of the lower thoracic and lumbar spine demonstrated a marked widening of the spinal canal with erosion of the pedicles of the twelfth thoracic and first lumbar vertebrae and some erosion of the pedicles of the second lumbar vertebra (Fig. 7). A spinal puncture was performed on December 26, 1941. The fluid was definitely serosanguineous containing many red and white blood cells. Supernatant fluid after centrifuging was xanthochromic. The lumbar puncture was repeated the following day and again bloody spinal fluid was

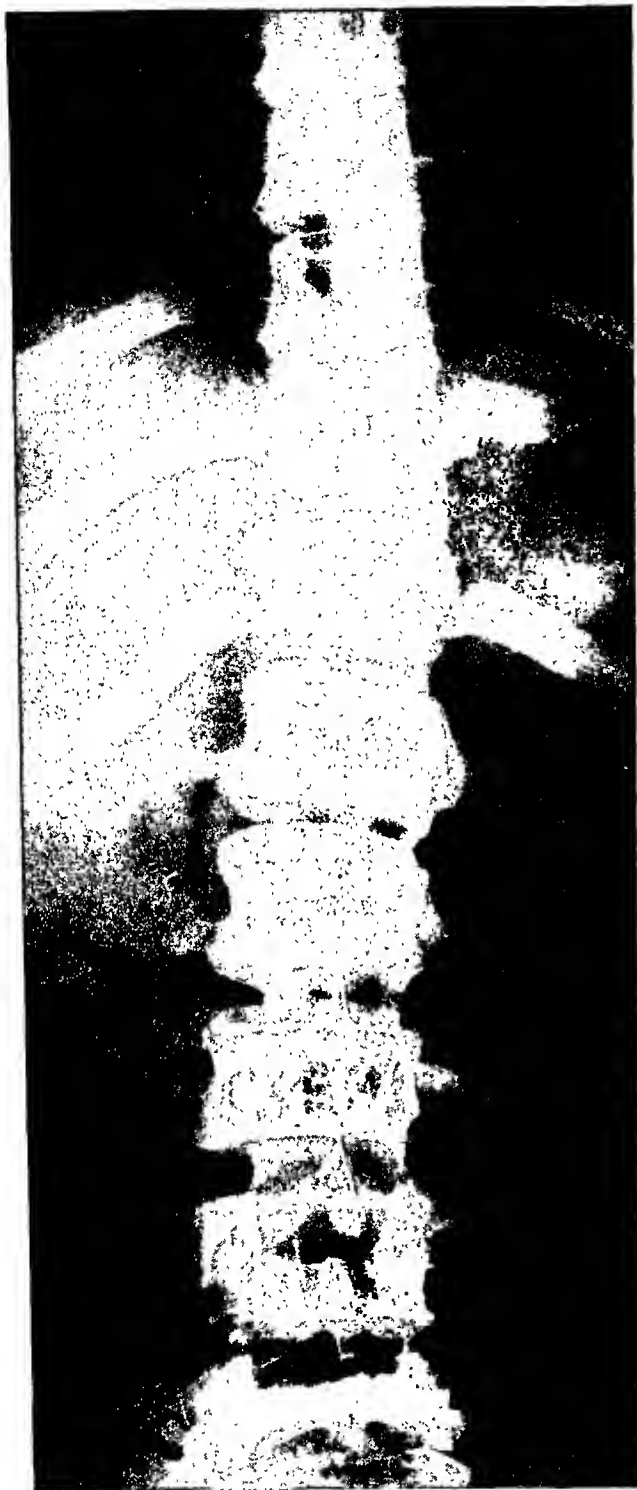


FIG. 7. Case IV. Anteroposterior roentgenogram of the spinal column showing the narrowing of the pedicles and dilatation of the spinal canal in the upper lumbar region. The interpedicular distances measured: thoracic 6, 18 mm.; 7, 19 mm.; 8, 20 mm.; 9, 22 mm.; 10, 25 mm.; 11, 26 mm.; 12, 33 mm.; lumbar 1, 40 mm.; 2, 33 mm.; 3 and 4, 30 mm.; 5, 33 mm.

removed. The dynamics could not be determined due to the uncooperativeness of the individual.

On January 8, 1942, the patient was anesthetized in the lower thoracic region by infiltration of 1 per cent novocaine into the skin and paravertebral muscles. A midline incision was carried from the tenth thoracic to the third lumbar vertebral spine. The muscles were separated from either side of the spines. It was apparent that the spines of the twelfth dorsal and first lumbar vertebrae were very short, measuring not more than 1.5 cm. in length and that the laminae at these levels were quite wide, long and not more than 1 or 2 mm. in thickness. The spinal canal was accordingly markedly dilated. The laminae of the twelfth thoracic, first and second lumbar vertebrae were rongueured away exposing a thick dura mater with thickened epidural fat. At the upper margin of the twelfth lumbar vertebra the epidural fat was much more normal and the spinal cord was seen to approach a normal size. Below this level the canal markedly widened to the level of the second lumbar vertebra where it again became smaller. The dura was incised in the midline. Instead of the normal spinal cord, a mass presented, completely filling the canal. One nerve root could be seen leaving this mass and passing across a large sclerotic blood vessel. The mass, yellow in color, appeared to be continuous with the normal spinal cord above and below. The right side of this enlarged spinal cord was covered with tangled fine blood vessels. On the left side there appeared to be a bluish colored cystic area. Upon incising the latter, a little clot of blood was encountered. The right side was then incised and at a depth of 1 cm. a well circumscribed mass was encountered. It appeared to be encapsulated. This mass was separated from the spinal cord with little trouble. It was about the size of a little finger, and had a smooth glistening capsule. It was tilted up from its base at the upper pole and seemed to be attached along its lower third to several large blood vessels. The capsule ruptured at this point and a pedicle about 1 cm. in diameter of yellowish "chicken clot" material extruded. A small amount of freshly clotted blood was present at the lower pole of this extruded mass. At this point profuse bleeding occurred from the center of the mass which appeared to be the calcified wall of an aneurysm. This wall was largely removed but profuse bleeding requiring muscle stamps and packing prevented further dissection. The dura mater was then closed, and the muscles approximated. The patient was in fair condition

at the conclusion of the procedure.

The specimen removed was a mass of homogeneous pink-staining tissue with a few elongated fibroblasts and occasional granular material, presumably early calcification. It was concluded that this material represented hyalinized connective tissue in the wall of an aneurysm.

The patient had a rather stormy convalescence requiring Monro tidal drainage. His urine gradually cleared and his anemia was treated by repeated blood transfusions. On January 21 he had a series of six convulsive seizures before the attacks could be controlled by phenobarbital medication. His blood pressure became elevated on January 26, being 174/138. His urine contained ten white and red blood corpuscles and had a moderate amount of albumin. He had another convulsion on the following day. The nonprotein nitrogen of the blood never exceeded 53.3 mg. per 100 cc. The patient continued to have convulsions about twice a week.

On February 12, the Monro tidal drainage was discontinued. His condition gradually improved. On March 31 he complained of blurring of vision and a macular retinitis was found. On April 18 his visual acuity was improving. He could move the right lower extremity, but dorsal flexion of the foot was very weak. The left hip and knee could be moved feebly. Both lower extremities were quite spastic and atrophic. The knee and ankle jerks were absent on both sides and the left plantar reflex was extensor. Sensory disturbances consisted of only a mild hypesthesia in the perianal region and above both ankles. The patient had a neurogenic bladder. He was discharged to his home and has been seen on two subsequent occasions.

On May 18, 1942, he was improving, had no pain, but was still incontinent. He was able to elevate both legs but had a marked analgesia of the left foot. Both knee jerks were active and plantar reflexes were flexor. He was unable to stand. He returned again on November 13, 1942, still having a great deal of difficulty with micturition. He was able to stand up with the aid of crutches, dressed himself, got into bed by himself. He stated that occasionally he felt an urge to urinate. The knee jerks were present on both sides but more active on the right. The right ankle jerk was hyperactive; the left ankle jerk sluggish.

*Comment.* Vascular anomalies of the spinal cord in children are rare and in those cases reported<sup>3,4,7,8,18</sup> no mention has been made of dilatation of the spinal canal. In retrospect it seems that an angiomatous neoplasm of the spinal cord should have been suspected in this case. The sudden onset with abdominal pain and the presence of xanthochromic spinal fluid on spinal puncture would suggest such a diagnosis for these are typical of a vascular anomaly of the spinal cord.<sup>7</sup> As in the case of Robertson<sup>18</sup> it seems likely that the severe pain initiating the symptoms in this patient was the result of hemorrhage into the spinal cord.

#### DISCUSSION

The enlargement of the spinal canal in these cases presumably occurred early in the development of the individual, probably at the time the ossification centers were laid down, since except for the last case there was no evidence of spinal cord compression either by lumbar puncture or at the time of operation. In fact, in the first two cases of myelodysplasia there was much more room in the subarachnoid space than usual. If this assumption is correct, it must then be assumed that the segments of the spinal cord did not change their position relative to the vertebral column as normally occurs. At three months of intra-uterine life the spinal cord segments correspond anatomically to the vertebral segments, but normally at birth the lower end of the spinal cord lies at the third lumbar vertebra, and in adult life at the first lumbar vertebra. In the lumbar region of the spinal cord, where most of the myelodysplasias occur, this lack of upward migration will cause considerable tension on the spinal cord and it probably is the main reason for symptoms developing early in adult life.

Although the enlargement of the spinal canal has been noted in some autopsy descriptions of diastematomyelia, it has not been recognized generally by clinical neurologists or roentgenologists. In discussing

the roentgenologic aspects of spina bifida occulta, Dittrich<sup>9</sup> does not refer to dilatation of the vertebral canal. In Elsberg and Dyke's paper<sup>10</sup> on enlargement of the spinal canal no mention is made of myelodysplasia as a cause of such dilatation, nor do Pancoast, Pendergrass and Schaeffer<sup>17</sup> refer to it. It might be assumed that the dilatation of the canal associated with congenital anomalies could be distinguished from that due to intraspinal neoplasm by the appearance of the pedicles—the enlargement in the first case being due to a congenital maldevelopment, the pedicles might not be so eroded or thinned as in the second instance where local pressure causes the dilatation. However, such a differentiation does not seem to be possible for the pedicles are thinned in the present series of cases.

#### SUMMARY

Three cases of myelodysplasia are presented associated with a dilatation of the spinal canal at the site of the anomaly. A case of vascular abnormality—angioma and aneurysm—of the spinal cord accompanied by enlargement of the spinal canal at the site of the lesion is also reported.

The roentgenographic and pathological manifestations of myelodysplasia are discussed.

Although neoplastic conditions cause most instances of roentgenographically demonstrable enlargement of the spinal canal, congenital abnormalities of the spinal cord should be considered as etiological factors.

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# CLINICAL AND ROENTGEN MANIFESTATIONS OF DISSECTING ANEURYSM OF THE AORTA\*

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## INTRODUCTION

**D**ISSECTING aneurysm of the aorta has been known to clinicians and pathologists for many years and the literature contains frequent references to this most interesting condition. However, the number of cases diagnosed correctly during life still remains extremely small. While relatively uncommon, this lesion is nevertheless of great clinical significance. In many instances, the dissection of the aorta develops with dramatic suddenness and is manifested by excruciating pain, collapse, and sudden death. The symptoms may closely simulate coronary disease, embolism or rupture of the heart, and errors in diagnosis are therefore very common. The clinical signs are often misleading and confusing. Since prompt and accurate diagnosis is of the utmost importance from the standpoint of both therapy and prognosis, an attempt will be made in this brief review of the subject to emphasize the important clinical and roentgen manifestations which are of assistance in establishing the diagnosis.

## ETIOLOGY

The incidence of dissecting aneurysm of the aorta varies widely in different series of reported cases. In hospital and private practice, the number is doubtless smaller than autopsy statistics indicate. This is owing to the fact that the lesion frequently occurs in persons who have had no previous complaints and death occurred suddenly. Hence, the studies in this condition are more often carried out by the coroner and medical examiner than by the clinician. According to Holland and Bayley,<sup>13</sup> the number of cases of dissecting aneurysm of the aorta is 1 in every 381 necropsies (0.3 per cent). The figures from the San Francisco Coroner's Office for the five year pe-

riod from 1933 to 1937<sup>13</sup> showed 60 instances of dissecting aneurysm of the aorta in a total of 8,438 autopsies (0.7 per cent). In this series, there were over twice as many cases of ruptured heart, which presented an incidence of 1.5 per cent. At the Boston City Hospital in the five year period from 1939 to 1943 inclusive, there were 4,240 necropsies, of which 15 revealed dissecting aneurysm of the aorta, an incidence of 1 in 283 (0.4 per cent). During this same interval there occurred 11 instances of ruptured heart (0.3 per cent) and 140 cases of coronary occlusion (3 per cent).

The condition is more common in men than in women, the ratio being about 3 to 1. The age distribution varies widely and, although the lesion is most common in middle and late adult life, cases have been reported at all periods from the teens to the ages of eighty and ninety. Trauma and exertion do not appear to play an important part. Occupation similarly does not enter as an etiologic agent. Syphilis is absent in the majority of cases, although a dissecting aneurysm may occur independently in the presence of a luetic aneurysm. Hypertension and atherosclerosis are very important etiologic factors and are found in a large proportion of the cases.

## PATHOGENESIS

A dissecting aneurysm is the lesion produced by penetration of the circulating blood between the layers of the wall of a blood vessel. It is not a true aneurysm in that the vessel is not dilated. There is still considerable disagreement as to the exact pathogenesis of dissecting aneurysm of the aorta. Some observers feel that arteriosclerosis is not a predisposing factor, but rather that the initial rupture of the intima which permits the blood to dissect between

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the layers of the blood vessel wall is produced by overstretching of the aortic wall due to the forcible action of a hypertrophied, compensated left ventricle. The great majority of pathologists are of the opinion, however, that the lining and medial wall of the aorta are diseased and weakened by localized destruction and the subsequent processes of repair. This area of repair is weaker than the vascularized fibrous tissues seen, for example, in lues. It is also generally assumed that there is an increase in the blood pressure and usually a tear in the intima. This latter manifestation may not always be demonstrable, however.

The dissection most commonly appears to have its beginning in small, localized areas of atheromatous degeneration. The lamina of the media is split by pressure from above, although as stated previously a tear of the lining cannot always be found. The blood then dissects from the point of rupture and the separation of the coats of the aorta and consequent extravasation of blood between the coats may involve a portion of the circumference or the entire lumen of the vessel. There may be an external rupture or a rupture into the lumen with subsequent formation of two tubes one inside the other, if the patient survives. The lesion may involve the ascending aorta, the arch, descending thoracic portion, the abdominal aorta or any combination of these. Extension of the lesion along the walls of the branches of the aorta is also frequently seen. The dissection is usually in the direction of the blood flow, but at times it also extends toward the heart.

Atherosclerosis is found in the great majority of cases of dissecting aneurysm and in many instances is far advanced and generalized. Syphilis is present in only a small proportion of the cases, however. It appears that syphilis uncomplicated by arteriosclerosis fails to provide the necessary background for the development of dissection of blood between the coats of the aortic wall. In fact, many observers are of the opinion that a granulomatous process such as lues fuses the lamellae more closely to-

gether and thereby actually lessens the tendency to dissection.

The arteries originating from the aorta may be affected in various ways by the development of the dissection. There may be complete separation of the artery at its point of origin; or the vessel may be obstructed partially or completely by hematoma formation. The periarterial sympathetic plexus may be damaged with the development of a spontaneous periarterial sympathectomy. Rupture into the mediastinum, the pericardium, or the pleural cavities is common and usually results fatally. Coarctation of the aorta and aortic hypoplasia predispose to dissection. Patients with disease of the vasa vasorum are also apt to develop this lesion.

#### SYMPTOMS AND SIGNS

In some instances, the onset is so sudden and the course so rapid that clinical diagnosis of dissecting aneurysm is extremely difficult or entirely impossible. The difficulties in arriving at a diagnosis are enhanced by the fact that death frequently supervenes before adequate studies can be carried out. However, as the manifestations are more clearly understood, a definite syndrome is becoming established and the number of cases correctly diagnosed during life is increasing greatly, particularly in recent years. The possibility of dissecting aneurysm must be carefully considered in the differential diagnosis in all patients presenting excruciating chest pain and collapse. As with many other rare and unusual lesions, the diagnosis will be made with ever increasing frequency if the condition is constantly borne in mind.

In the typical acute case, there is a sudden onset of severe, excruciating pain which may be described variously as tearing, crushing or agonizing and is accompanied by a sense of impending death. The intensity reaches its maximum almost immediately and may last for only a few moments or persist for hours to several days. In some instances, the pain is moderate or slight and rarely is entirely absent. The pain may

be located in the chest, abdomen, neck, head, back or lower extremities and usually extends progressively or irregularly from one area to another. The arms are less commonly involved. If radiation to the upper extremities occurs, it is more apt to involve the outer surfaces. As the dissection extends along the aorta, the pain usually spreads rapidly. Hence, radiation in rapid succession from the thorax to the abdomen, thighs and extremities should at once call to the observer's mind the possibility of this lesion. The pain may persist undiminished for a considerable period or become intermittent, lessen or disappear completely. The site of the pain and its radiation vary with the location of the lesion and are important in indicating the portion of the aorta involved. The progress of the dissection may be followed by the varying positions of the symptoms. The pain is usually not precipitated by exertion. The patient is, in most instances, in apparent good health prior to the onset.

Collapse and syncope with shock are frequently severe, although in some cases these manifestations are moderate or slight. There is in many patients, a long history of hypertension. The blood pressure may be maintained at a high level for a considerable period during the stage of dissection, or may drop to a very low level. The blood pressure may be unequal in the two arms and in the legs. The heart is usually enlarged and the rate is rapid. A diastolic murmur is apt to appear in the aortic area. The common signs of aortic regurgitation are absent, however. The peripheral pulses may be altered. The pulse tension and volume of the aorta are diminished because of the partial obstruction of its main branches by the dissection and hematoma formation.

Nausea and vomiting are common. Fever and leukocytosis of a moderately high degree are present in a large majority of cases. The icteric index is elevated and may remain so for days or weeks after the onset. Numbness, coldness, and weakness of the extremities are frequent. Paresthesia and hyperesthesia are less often seen. If the

renal vessels are involved, there is hematuria, anuria and uremia. Bleeding into the mediastinum and pericardium may result in cardiac tamponage with marked distention of the cervical veins and an elevated venous pressure.

Neurologic manifestations indicate involvement of the vessels of the spinal cord. Paresis and paralysis are commonly seen and may be variable and inconstant, wandering paralyzes being a frequent occurrence in patients with dissecting aneurysm. Permanent paralysis may occur. Urinary retention develops due to sphincteric involvement. Obstructive signs are seen in the peripheral circulation if there is involvement of the arteries arising from the aorta. Convulsions, coma, and hemiplegia may result if the cerebral circulation is interfered with.

The electrocardiographic findings are not, as a rule, characteristic and may actually be misleading. Thus, if the dissection is in the region of the root of the aorta with involvement of the first portion of the coronary artery, acute myocardial infarction may result with consequent changes in the electrocardiogram which cause confusion in the diagnosis.

In the acute case, death may occur at the very onset of the attack or supervene after a variable interval. The average duration of life is approximately two to three weeks. In many instances, the dissection becomes arrested and appears to heal. Most of these patients succumb subsequently, the cause of death being either the development of a new dissection or intractable heart disease. The usual length of life in the old or healed cases is two to three years after the original dissection.

#### DIFFERENTIAL DIAGNOSIS

Coronary thrombosis is the condition usually confused with dissecting aneurysm of the aorta. The previous history in coronary disease is frequently helpful. In coronary thrombosis, there is absence of the peripheral vascular occlusions and paralyzes which may be so prominent in dissecting

aneurysm of the aorta. Syncope at the onset of dissection is an important point in the differential diagnosis.

Embolism and thrombosis of the peripheral arteries and the iliacs may be confused with dissecting aneurysm. In the latter condition, the pain is usually thoracic or abdominal at the onset. Syphilitic aneurysm with rupture may be impossible to distinguish from dissecting aneurysm, especially since the two conditions may exist simultaneously in the same patient. Similarly, rupture of the heart may give a clinical picture closely simulating dissecting aneurysm of the aorta.

#### TREATMENT

Therapy is entirely expectant and symptomatic. Rest and sedation are of the utmost importance. Correct diagnosis is extremely important to avoid the institution of therapeutic measures which may serve to increase the damage.

#### ROENTGEN FINDINGS

The roentgen picture, while not clear cut or pathognomonic in all cases, may be of assistance in establishing the diagnosis and in following the progress of the case. The changes vary with the location of the lesion, the extent of the extravasation, and the stage of the process at the time the patient is seen. The most significant finding is widening of the supracardiac area. The increase in width may be to the right, the left or both. It presents a localized bulge if the extravasation is circumscribed or sacculated and a generalized widening if the extravasation is diffuse and widespread. The aortic pulsations are commonly diminished, although in some instances the movements of the aorta are normal or increased. If there is extensive accumulation of blood in the mediastinal tissues, the aortic pulsations are absent. Cardiac hypertrophy is present in many cases and is frequently marked, with vigorous pulsations. This is especially true in long-standing or arrested cases. The enlargement of the heart is in the region of the ventricles. During the acute stage, the cardiac pulsations may be diminished.

The trachea and esophagus are usually displaced. The displacement is to the right or left depending on the site of the dissection. If the lesion involves the large branches of the aorta, there is an increase in the width of the shadow of the innominate artery with a band of increased density in the paravertebral portion of the upper lung field. With extravasation of blood into the pericardium, the findings are those of pericardial effusion. Similarly, rupture into the pleural space produces the usual roentgen manifestation of fluid. Effusion occurs more frequently on the left, but may involve the right side or be bilateral.

In the diagnosis of dissecting aneurysm of the aorta, it is particularly important that the roentgen studies be carried out in close cooperation with the clinician. Doubtless the reason that the diagnosis has been made so seldom in the past is that the possibility of this lesion has not been borne in mind. As it is considered more frequently in the differential diagnosis, dissecting aneurysm of the aorta will be diagnosed with increasing certainty. Since the prognosis is extremely grave in this condition, the importance of accurate diagnosis is obvious. A sudden increase in the width of the aortic shadow roentgenologically is diagnostic of a dissecting aneurysm; similarly, a marked widening of the innominate shadow is very significant. Disappearance of the aortic pulsations indicates extravasation into the pericardium. These manifestations may require careful roentgenoscopic and roentgenographic study and in the acutely ill cases can be performed only with extreme caution and care. Laminagraphic studies of the aorta may be of value in localizing the portion of the aorta involved and delimiting the extent of the process.

#### CASE REPORTS

CASE I. J. A., male, white, aged sixty-five. Four months previously, he had been hospitalized with a diagnosis of arteriosclerotic heart disease and cardiac hypertrophy. For several weeks, he had had marked dyspnea on exertion, orthopnea, and mild epigastric pain which was aggravated by food. On the day of the present

admission, he was suddenly discovered by his family in a state of deep stupor.

Physical examination revealed a well developed and nourished male with moist skin and mild stiffness of the neck. The heart was enlarged to the left; there were no murmurs and the rhythm was regular.  $A_2$  was greater than  $P_2$ . There were slight dullness and râles at the right base. There was weakness of the right leg and the right knee jerk was less than the left. Both ankle jerks were absent. The Babinski sign was positive on the right. The blood pressure on admission to the hospital was 160/110, whereas previously it had been 240/135. Temperature was 97.8° F., pulse 80, respirations 22. The urine showed a very slight trace of albumin. The red blood cell count was 3,810,000; white cell count 9,600 and the hemoglobin 71 per cent. The Hinton test was negative. Non-protein nitrogen was 43. The electrocardiogram showed left ventricular predominance with ventricular premature beats in lead II and auricular premature beats in leads II and III.

The patient was digitalized and fluids were restricted. The temperature was slightly elevated, pulse continued at about 100, and the respirations varied from 22 to 32. After four days in the hospital, he was conscious and rational and the weakness of the leg disappeared. His blood pressure rose to 218/130. Roentgen examination revealed an increase in the width of the aorta bilaterally and a marked generalized increase in the size of the heart shadow. There were congestive changes in both lung fields and fluid at the right base. On the eleventh day of his stay in the hospital, he suddenly became markedly dyspneic, collapsed and died.

At autopsy, there was found a dissecting aneurysm of the aorta, with rupture into the pericardium; fibrinous pericarditis; hypertensive heart disease; and atherosclerosis of the aorta. The pericardial sac was distended and contained 1,500 cc. of freshly clotted blood. There was fibrinous pericarditis. The heart was markedly hypertrophied and weighed 800 grams. The myocardium was twice normal in thickness. The intima of the aorta presented numerous golden-yellow plaques scattered over its surface; there was no thickening of the aortic wall. About 2 cm. above the base of the left aortic cusp, there was an irregular, transverse laceration of the intima of the aorta. This area was about 2 cm. in length and extended through the intima and media to connect with a cavity filled with freshly coagulated blood lying within

the wall of the aorta. The cavity extended downward in the aortic wall to the origin of the aorta and a sinus communicated directly with the pericardium.

CASE II. C. W., male, colored, married, aged forty-nine. He was well until three years previously, when he began to have dyspnea occasionally while engaged in his work of carrying baggage at a railroad station. There was no pain in the chest, orthopnea or edema. His physician told him that he had high blood pressure and restricted his activities. The day prior to admission, there was a very sudden onset of extremely severe pain in the left anterior chest, radiating to the left upper quadrant and to the left lower quadrant of the abdomen. He felt extremely weak and sweated very profusely. A hypodermic injection produced relief for a few hours, after which the pain recurred in the left lower abdomen.

On admission, there was dullness and suppression of the breath sounds over the left lower chest. The heart was enlarged to the left and there was a harsh systolic murmur over the precordium; the sounds were of fair quality and the rate was 120. The blood pressure in the right arm was 112/64 and in the left 128/74. The temperature was 98.6° F., pulse 120, respirations 24. The red blood cell count was 5,000,000; white cell count 15,000, and hemoglobin 85 per cent. The urine contained a trace of albumin and many white blood cells. Roentgen study of the chest revealed homogeneous density over the entire left lung field, indicating a large amount of fluid in the left pleural space. He survived three days and died very suddenly.

At autopsy, there was a dissecting aneurysm of the thoracic and abdominal portions of the aorta with rupture into the mediastinum and left pleural cavity. The arch of the aorta presented an oblique rent about 3 cm. in length in the intima along its superior aspect. Opposite this, there was a tear in the adventitia which was separated from the media by a large clot. The dissection extended downward to a point about 6 cm. below the level of the diaphragm. The heart weighed 550 grams and was fairly normal. There was 150 cc. of blood in the pericardial cavity. There was marked atherosclerosis of the aorta.

CASE III. A. C., female, white, aged seventy-three. For several years, the patient had shown mental changes with emotional instability, irritability, and loss of memory. One year ago, she had had a slight shock. She was a Christian

Scientist and an accurate history could not be obtained as she was unwilling to discuss her illness. One day prior to admission, she fell while walking in the street and could not rise. When seen in the hospital, she was unable to use her right arm or leg and her speech was so thick as to be practically unintelligible. There was weakness of the left side of the face and a slight droop of the left side of the mouth. The tongue protruded to the left. The heart was enlarged slightly to the left; the sounds were regular and of good quality and the rate and rhythm were normal. There was a systolic murmur at the apex. The blood pressure was 180/100. The right leg was spastic. The red blood cell count was 4,600,000; the white cell count 6,300 to 11,400 and the hemoglobin 89 per cent. The Hinton test was negative. Electrocardiographic studies showed left ventricular predominance and partial heart block. Roentgen examination of the chest showed that the aortic shadow was markedly widened and there was extensive calcification in the region of the arch of the aorta. The patient's condition remained unchanged for about two months, after which time she developed bronchopneumonia and died.

Autopsy showed a healed dissecting aneurysm of the aorta and right common iliac artery. There was a large opening in the aorta in the region of the beginning of the arch; the lumen was divided into two portions and the entire aorta from this point continued as a double vessel with two lumens of nearly equal size. The entire aorta was calcified and sclerotic. The heart weighed 300 grams and was not remarkable except for marked sclerosis and calcification of the coronary arteries.

CASE IV. J. D., male, white, aged forty-two. About three years ago, the patient was hit by an automobile and rendered unconscious. While at the hospital at that time, he learned that his blood pressure was "210." Since the accident, he had had dizziness, poor vision and soreness behind the left ear. During the past year, he had had frequency and nocturia. Twelve hours prior to the present admission, he was suddenly seized with a very severe pain in the anterior portion of the upper chest. The pain was bilateral and did not radiate. There was profuse sweating and alternating feeling of heat and cold. There was no dyspnea. He vomited several times and had a severe, dry cough. On physical examination, the heart was enlarged to the left and the impulse was heaving; the

sounds were of fair quality with  $A_2$  greater than  $P_2$ . There was a friction rub at the left second interspace anteriorly. The red blood cell count was 4,250,000; white cell count 12,750, and the hemoglobin 87 per cent. The Hinton test was negative; non-protein nitrogen 40; temperature 98° F.; pulse 90; respirations 20. The blood pressure was 170/110. The electrocardiogram showed left ventricular predominance and right bundle branch block. Roentgen examination revealed marked widening of the supracardiac area, particularly in the region of the arch and descending aorta. The heart was enlarged to the left in the region of the ventricle. During his stay in the hospital, he complained of precordial pain and was partially confused mentally. On the sixteenth day, he suddenly complained of severe chest pain and a sense of impending death. Within a few moments of the onset, he died.

At autopsy, there was 2,000 cc. of clotted blood and fluid in the left pleural cavity, 300 cc. of fluid blood in the right pleural space and 500 cc. of amber fluid in the pericardial sac. The heart weighed 640 grams; the epicardium and endocardium were normal. There were a few atheromatous plaques on the valves. At the posterior aspect of the arch of the aorta, there was a ragged, transverse tear in the intima measuring 1.5 cm. in length. The intima was separated throughout the entire circumference of the aorta, with the exception of a very narrow area posteriorly, from the level of the subclavian artery to the proximal portions of the internal iliac arteries. The cavity thus formed contained a small amount of clotted blood at its extreme lower end. Two fresh ruptures of the aorta, each measuring about 2 cm. in length, were present in the superior aspect of the aorta in the region of the junction of the arch and the descending portion. In the intima, there were many yellow plaques with calcification. The atherosclerotic changes were most marked in the abdominal aorta.

CASE V. F. D. L. Q., male, Filipino, aged forty. One year ago, he was ill with a bleeding peptic ulcer and hypertension. His blood pressure at that time was 168/118. Two weeks ago, a physical examination (pre-employment) revealed "high blood pressure." Two nights ago, at 1:30 A.M., he developed persistent orthopnea and discomfort in the chest. Early the following afternoon, he suddenly felt a sharp, burning pain in the epigastrium; the pain was boring and burning and did not radiate. After sedation,

he was sent to the hospital. On admission, the skin was dry and cyanotic. The heart was enlarged to the left, regular, rate 130, with weak sounds and no murmurs.  $P_2$  was greater than  $A_2$ . The blood pressure was 100/55 in the right arm and 100/60 in the left. The red blood cell count was 6,000,000; the white cell count 27,600, and the hemoglobin 95 per cent. Non-protein nitrogen was 46. Electrocardiogram showed left ventricular predominance which was interpreted as "possibly coronary thrombosis, but not characteristic." Roentgen studies showed the aorta moderately widened and the heart enlarged to the left. On the second day in the hospital, he suddenly went into shock and died.

Postmortem examination revealed a dissecting aneurysm of the aorta, hemopericardium, aortic atherosclerosis, and cardiac hypertrophy with an infarct of the left ventricle. The pericardial sac contained 200 cc. of clotted blood. The heart weighed 500 grams and there was narrowing of the coronary arteries with numerous atheromatous plaques in the intima. In the aorta, at a point about 1 cm. above the aortic wall, there was a sharp rupture of the intima and a portion of the media. This area measured 4 cm. in length. A smaller slit measuring 1 cm. in length was also present in this region. The wall of the aorta was dissected from its point of origin to the mouth of the celiac artery. There was hemorrhagic extravasation into the adventitial tissues at the root of the pulmonary artery and the aorta. The tissue layers in this region were separated and contained small clots of blood. There were many small atheromatous deposits scattered throughout the entire aorta.

CASE VI. W. R., male, white, aged seventy-five. This patient was admitted to the hospital in pain and moaning constantly. He was unable to give any details as to his history and was unaccompanied by anyone who knew the details of his illness. He was extremely restless and appeared very seriously ill. The heart was not enlarged. A rough systolic murmur was heard over the entire precordium. The blood pressure was 122/58 in the left and 104/52 in the right arm. Temperature was  $101^{\circ}$  F.; pulse 118; respirations 26. The urine contained a slight trace of albumin and many white blood cells. The white blood cell count was 21,000 and the hemoglobin 88 per cent. The Hinton test was negative. Non-protein nitrogen was 33. Roentgen examination revealed marked widening of the aortic shadow and enlargement of the heart outline. He became progressively worse

during his hospital stay and died on the fifth day.

Postmortem examination showed an extensive dissection of the aorta involving over one-third of its circumference and practically its entire length. There was also dissection of both common and external iliac arteries, the innominate, the left common carotid, and the left subclavian arteries for a distance of about 3 cm. About 500 cc. of blood was found in the pericardial cavity. The heart weighed 520 grams and showed acute bacterial endocarditis and a healed rheumatic lesion.

CASE VII. J. A., male, white, aged fifty-five. About six hours prior to admission, while talking quietly with a friend, he suddenly experienced a sharp pain in the chest. The pain was so severe that he was unable to draw a deep breath; it extended directly through to the back, and no relief was obtained by lying down. He "broke into a cold sweat," and vomited. About seven years previously, he recollected having experienced a similar, less severe attack; otherwise, he had been well. At the time of admission, the heart was enlarged to the left, there was a systolic murmur at the apex, and  $A_2$  was accentuated. The blood pressure was 240/120. The red blood cell count was 4,300,000; the white cell count 20,000 and the hemoglobin 85 per cent. There was a large trace of albumin in the urine. The Hinton test was negative and the non-protein nitrogen 55. Electrocardiographic studies showed left ventricular predominance and auricular premature beats in lead II. Roentgen studies of the chest showed an increase in the width of the supracardiac area to the left in the region of the descending aorta. The heart was enlarged to the left. He continued to feel weak. The blood pressure dropped to 135/75 in the right arm and 140/90 in the left. On the fourteenth day of his hospital stay, he collapsed suddenly and died.

At autopsy, the heart showed coronary sclerosis, otherwise was not remarkable; it weighed 450 grams. There was 500 cc. of clear fluid in the pericardium. In the aorta, at the level of the left subclavian artery, there was an incision-like rupture of the intima and the intima was dissected from this point to the bifurcation of the common iliacs. At a point about 6 cm. below the above described intimal break, a second, similar lesion was present with the formation of a false lumen. There was also dissection of the superior mesenteric artery for a considerable distance.



CASE VIII. P. G., male, white, aged sixty-four. Two weeks prior to admission, he became ill with a cold and developed marked orthopnea. There were no chills or rusty sputum. About twenty-four hours before entering the hospital, he was suddenly awakened by a very sharp pain just below the xiphoid. The pain was aggravated by breathing and radiated to the left shoulder. On admission, he was slightly cyanotic. There were moist râles at the left base. The heart was enlarged to the left, the sounds were of poor quality, the rhythm regular and the rate 92. A to and fro murmur was present over the precordium and there was a palpable thrill in the second interspace on the right. The liver was enlarged and there was edema of the legs. The blood pressure rose to 110/80. The red blood cell count was 4,780,000; the white cell count 9,550, and the hemoglobin 78 per cent. The Hinton test was negative, the non-protein nitrogen 36 and the icteric index 8. Electrocardiographic studies showed left ventricular predominance and Q-T interval was prolonged by 0.02 second. Roentgen examination revealed a widening of the supracardiac area bilaterally, enlargement of the heart shadow both to the right and left, and congestive changes in both lungs. He was digitalized but continued to have substernal pain and cyanosis. On the third day, the blood pressure fell to 70/30. The following day, he died suddenly.

At autopsy, the pericardial cavity was filled with a soft, dark red blood clot which formed a coat 2 cm. in thickness over the heart. There was a large perforation in the right lateral portion of the ascending aorta at a point about 4 cm. above the aortic valve; the perforation measured about 1 by 0.5 cm. and communicated directly with the pericardial cavity. The ascending aorta showed an aneurysmal dilatation, its circumference measuring 11 cm. as compared with 6.5 cm. in the transverse portion. The intima and media presented a large rupture measuring 7 by 2 cm. There was an accumulation of dark red blood in the adventitial tissue and between the adventitia and the media; this extended along the aorta to the mid-thoracic region. A few calcified plaques were present in the ascending aorta. The lungs showed congestion. The heart weighed 600 grams and the left ventricle was enlarged. There was marked stenosis with calcification and thickening of the aortic valve. The left coronary artery showed yellow, irregular plaques.

CASE IX. M. M., male, white. The patient had been perfectly well. About 9 P.M. on the day of admission, he suddenly experienced a feeling of dizziness which was soon followed by a severe pain in the region of the jaw. He became pale, dyspneic and sweated profusely. Sudden collapse followed and he was removed to the hospital. On admission, he was restless; the skin felt cold and moist. He complained of substernal pain. The heart was enlarged to the left and the sounds were faint; no murmurs were present. The blood pressure was 80/40; temperature 98° F., pulse 62, and respirations 15. The red blood cell count was 4,200,000; white count 16,000; and the hemoglobin 70 per cent. The Hinton test was negative. The urine showed a very slight trace of albumin and a few white blood cells. An electrocardiogram revealed left ventricular predominance and prolonged Q-T interval of 0.02 second. Roentgen studies showed marked, bilateral widening of the supracardiac area, enlargement of the heart shadow and fluid at the right base (Fig. 1). During his stay in the hospital, he complained constantly of pain in the chest. The blood pressure rose to 90/70. On the sixth day, there was a sudden exacerbation of the pain, the patient gasped and suddenly died.

At autopsy, there was 70 cc. of partially clotted blood in the pericardium. The heart was moderately enlarged, weighing 520 grams. In the superolateral surface of the arch of the aorta at a point about 2 cm. beyond the orifice of the left subclavian artery, there was a transverse cleft in the intima which measured 4 by 1 cm. From this point a tract extended along the right lateral margin of the aorta to the level of the orifices of the renal arteries. The intima of the aorta presented a rough, wrinkled appearance and several scattered calcareous deposits. The pathologist's diagnoses were: dissecting aneurysm of the ascending aorta with rupture into the cavity and an old, healed, dissecting aneurysm of the thoracic aorta; hypertensive heart disease; atherosclerosis of the aorta and the coronary arteries.

CASE X. J. M., male, white, aged forty-eight. The patient entered the hospital after collapsing suddenly in the waiting room of a railroad station. He stated that he had had no sleep during the previous thirty-six hours. He was unconscious for fifteen minutes. On admission to the hospital, his complaints were weakness and a burning feeling in the throat. Ten years pre-



viously, his physician had told him that he had hypertensive heart disease and that his blood pressure was 220. However, he had felt well and had been able to continue his work. At the time of entry, he was drowsy and ashen-gray; the skin was cold and clammy. The maximum cardiac impulse was palpable in the fifth left interspace 13 cm. from the mid-sternal line. There were no cardiac murmurs; the heart sounds were of fair quality; there were occasional extrasystoles; the rate was 80. There were râles with diminished resonance at the left base. The red blood cell count was 3,340,000; white cell count 14,100, and hemoglobin 90 per cent. The urine contained moderate amounts of albumin. The electrocardiogram showed abnormal S-T segments and T waves upright in all leads with low origin in leads II, III, and IV. Roentgen examination of the chest revealed



FIG. 1. Case IX. Dissecting aneurysm of the aorta with rupture into the pericardium. The supracardiac area is increased markedly in width bilaterally. To the right, this density is uniform and presents a sharply defined, slightly rounded lateral margin, indicating hemorrhage into the pericardial sac. On the left, the dissection has resulted in an area of density adjacent to the shadow of the descending aorta and the border of the heart. This area is less dense than the shadow of the heart, and the aorta and cardiac border are visible through it. The aortic knob is prominent. The heart is large. There is fluid at the right base.



FIG. 2. Case X. Dissecting aneurysm of the aorta with rupture into the pericardial sac and the right pleural space. There is widening of the supracardiac area both to the right and left. The heart is enlarged. There is fluid at the right base.

cardiac hypertrophy and increase in the width of the supracardiac shadow (Fig. 2). On his second day in the hospital, he developed moderate pain in the chest and became very restless. The veins of the neck became distended. The blood pressure was 60/50 and pulse 100. The following day, the blood pressure rose to 110/80. His condition remained unchanged until the fifth day when he suddenly developed shock and died.

At the postmortem examination, there was 500 cc. of sanguineous fluid in the right pleural cavity and 450 cc. of blood in the pericardial cavity. The heart weighed 550 grams and the myocardium was firm and red. The valves appeared normal. The coronary artery was tortuous and dilated. There were several large atheromatous plaques in the ascending portion of the aorta. At a point about 2 cm. above the aortic valve, there was a tear 3.5 cm. in length extending through the intima. There was a dissection of the subadventitial tissue for a short distance from this lesion. A few atheromatous plaques were present in this portion of the aorta, and large atheromatous areas were found in the descending thoracic and abdominal aorta.



FIG. 3. Case XI. Dissecting aneurysm of the aorta. *A*, there is an area of increased density extending laterally from the shadow of the aortic knob and descending aorta. There is no widening of the supracardiac area on the right side. The heart is enlarged to the left in the region of the ventricle. *B*, same patient five days later. The area of increased density in the left paravertebral region has increased very markedly in size and is more dense than previously. This rapid increase in the width of the aortic shadow is one of the most important findings in dissecting aneurysm.

CASE XI. T. L., male, white, aged thirty-two, taxi driver. Two hours prior to admission, while opening the door of a closet at home, he experienced a sudden, severe pain in the upper mid-back. The pain radiated to the epigastrium and he vomited clear fluid. His face became ashen, his lips blue, and his extremities clammy; he did not collapse, however, and was able to remain standing. Seven years previously, he had been in a sanatorium for sixteen months with tuberculosis and at that time, he was told that he had hypertension and a systolic murmur at the apex of the heart. For the past six months, there had been moderate dyspnea on severe exertion and a sense of pressure in the region of the sternum in cold weather. On admission, he was in acute distress and writhing in bed. The heart was enlarged slightly to the left; the rate was 100 and regular. There was a harsh systolic murmur at the aortic arch and a thrill, transmitted to the neck; there was also a diastolic murmur at the aortic area and a systolic murmur at the apex. The abdomen showed marked spasticity but was not tender. Electrocardiographic findings were as follows: normal

sinus rhythm; rate 100; P-R interval 0.16; Q-S interval 0.10; T waves upright in all leads; P waves broad; marked left axis deviation. Roentgen examination of the chest showed an area of increased density in the left mid-chest, adjacent to the shadow of the descending portion of the aorta, and enlargement of the heart to the left in the region of the ventricle (Fig. 3*A*). Re-examination five days later showed the area of density in the left paravertebral region markedly increased in size (Fig. 3*B*). The blood pressure was 180/50 and was equal in the two arms. There were râles at the right base. On the third day, he became irrational and incontinent. Then suddenly he became cyanotic, dyspneic and comatose. A pulsating mass appeared just below the epigastrium. He rallied for a few hours and then died suddenly.

At postmortem examination, 2,000 cc. of fluid blood and clots were present in the left pleural cavity. The pericardial cavity contained 60 cc. of clear yellow fluid. The heart weighed 540 grams and was markedly enlarged. The aorta showed moderate atherosclerosis of the lower thoracic and abdominal portions. Five centi-

meters beyond the orifice of the left subclavian artery, there was a longitudinal tear about 1 cm. in length in the intima of the aorta. The media was dissected from this point down to the iliac arteries. There was dissection of the right renal artery for a distance of 1 cm. with complete occlusion of its lumen.

CASE XII. C. D., female, white, aged sixty-eight, widow. Four hours before admission, while climbing a flight of stairs, she experienced a sudden tearing sensation between the shoulders radiating to the epigastrium. The pain lessened but after about one-half hour she developed a complete sensory and motor paralysis below the level of the eighth thoracic vertebra. On admission, she was in shock, cyanotic and pulseless; no blood pressure reading could be obtained. The heart was enlarged to the left and there was substernal dullness with marked widening of the mediastinum. A gallop rhythm was heard over the precordium. The lower margin of the liver was 2 inches below the costal margin. Neurologic studies revealed motor and sensory loss below the level of the eighth dorsal vertebra. There was tenderness over the entire spine. The left knee-jerk was present. The plantar reflexes were weakly extensor. Lumbar puncture showed 90 white blood cells per cubic centimeter, otherwise normal. Electrocardiographic studies revealed a shifting auricular pace maker with bursts of nodal and ventricular tachycardia; the rate was 135; P-R interval 0.06 and 0.20; T<sub>1</sub>-T<sub>2</sub> obscured; T<sub>2</sub>-T<sub>4</sub> up; left axis; occasional dropped beats. Roentgen examination showed a very marked increase in the width of the supracardiac area bilaterally and enlargement of the heart to the left (Fig. 4). The patient was given clyses of 3,000 cc. of 5 per cent glucose in water. In spite of adequate fluid intake, her output during the first twenty-four hours was only 20 cc. and on the remaining days only about 10 cc. The non-protein nitrogen was 50 on admission and rose to 102 before death. There was no appreciable change in her condition and she died quietly.

At autopsy, a slit 2 cm. in length was present in the intima of the aorta about 5 cm. above the aortic valve. The intima was dissected throughout the entire ascending arch and descending aorta to a point 1 cm. below the origin of the left renal artery. There was dissection of the fifth to twelfth intercostal arteries. The left renal artery had been occluded by the dissection and there was complete infarction of the left



FIG. 4. Case XII. Dissecting aneurysm of the aorta. The supracardiac area is increased markedly in width bilaterally. The heart shadow is enlarged to the left.

kidney. The right kidney and its artery were normal. On the outer surface of the aorta, there was a rupture slightly distal to the aortic valve and within the pericardial cavity. The heart weighed 500 grams, otherwise it was normal. There was 300 cc. of clear yellow fluid in the right chest and 200 cc. of fresh unclotted blood in the pericardial cavity.

#### SUMMARY

Dissecting aneurysm of the aorta is relatively uncommon; nevertheless this condition is of great clinical significance as it may be confused with coronary disease, embolism or rupture of the heart.

A dissecting aneurysm is produced by penetration of the circulating blood between the layers of the wall of a blood vessel and is usually associated with a tear in the intima of the artery, hypertension, and atherosclerosis. Rupture into the mediastinum, the pleural cavities or the pericardium is common and usually results fatally.

In the acute cases, there is usually sudden onset with severe pain in the chest or

abdomen. The pain is apt to radiate rapidly as the dissection progresses; collapse, shock, and death may occur immediately or be delayed for weeks or months.

The roentgen studies are of value in establishing the diagnosis and in following the progress of the case. The significant roentgen findings are increase in the width of the shadow of the aorta, cardiac hypertrophy, pericardial effusion, and fluid in the pleural space.

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# PREPYLORIC DIVERTICULUM OF THE STOMACH DEMONSTRABLE ONLY BY PRESSURE ROENTGENOGRAMS

## REPORT OF A CASE\*

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**D**IVERTICULA occur in the stomach much less frequently than in other portions of the gastrointestinal tract.<sup>4</sup> They are usually situated at the fundus in the region of the cardiac orifice. They are rare in other portions of the stomach. Because the diverticulum was located in the lower end of the stomach and because it could be demonstrated only by pressure, this case seems worthy of record.

Opinions concerning the classification of gastric diverticula vary. They have been classified according to etiology as congenital or acquired, according to morphology as true (if they contain all the elements of the gastric wall) or as false (if they do not), and according to mechanism as pulsion or traction types.<sup>4</sup> Rivers, Stevens and Kirklin<sup>4</sup> reported 14 cases proved at operation or autopsy; of 6 of these cases examined roentgenographically only 2 were true diverticula located at the cardiac end, the remaining 4 being secondary to ulcer or neoplasm. It is of interest that 6 of the 14 cases were located in the prepyloric region, 6 at the fundus and 2 midway between the two. All of the 5 gastric diverticula found at autopsy, at the Presbyterian Hospital, were situated in the cardiac end of the stomach. With the exception of the present case, all of the gastric diverticula demonstrated by routine examination, in the Department of Radiology, were located in the same region. Tilger<sup>6</sup> reported a traction diverticulum of the prepyloric region resulting from a gallbladder adhesion.

Gastric diverticula may or may not produce symptoms.<sup>1</sup> Relief of such symptoms

has been recorded following surgical treatment.<sup>2,5,7</sup>

The outpouching at the fundus is usually demonstrated with ease and may be differentiated from ulcer, which it may simulate, because it usually retains barium after the stomach is empty. The prepyloric diverticula which have been demonstrated by roentgen methods produced obvious extraluminal barium shadows (Tupper<sup>7</sup>). Sutherland<sup>5</sup> reported a filling defect in the gastric shadow due to pressure of the blood filled diverticular sac on the stomach.

## CASE REPORT

A. G. (Unit No. 641925). A sixty year old Austrian tailor came to the Vanderbilt Clinic May 13, 1941, because of a contracture of the right ring finger of three years' duration. The presenting medical problem was whether the patient had Dupuytren's contracture or rheumatoid arthritis. The routine history disclosed that the patient had had one or two bloody stools and recent constipation. This, together with slight epigastric tenderness, led to a roentgen examination of the stomach on May 26, 1941. The roentgenoscopic examination disclosed an extraluminal barium shadow about 1.0 cm. in diameter in the prepyloric region which could be demonstrated only by pressure of the gloved hand and which was completely obliterated by normal peristaltic waves (Fig. 1 and 2). This shadow was reproduced on four pressure roentgenograms (Fig. 3). The long axis of the shadow paralleled the longitudinal rugae. This shadow was considered to be suggestive of an ulcer. A second roentgen examination, July 8, 1941, reproduced this shadow as described above.

Gastroscoy was done by Dr. Armistead C.

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FIG. 1. Diverticulum of the lower end of the stomach. Routine roentgenogram of the stomach in the prone oblique position fails to disclose an extraluminal shadow in the prepyloric region.

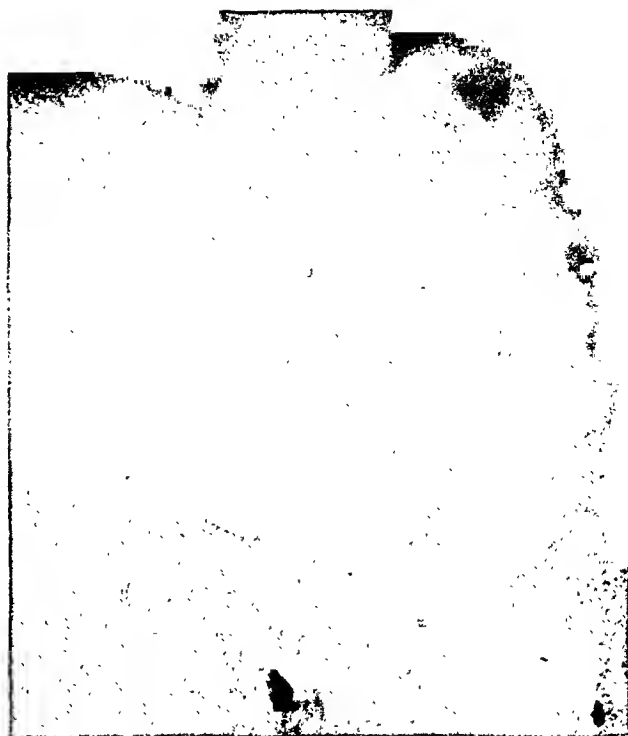


FIG. 2. Diverticulum of the lower end of the stomach. Routine roentgenogram of the stomach in the erect position fails to disclose an extraluminal shadow in the prepyloric region.

Crump, July 23, 1941, and revealed what appeared to be a pocket-like depression on the posterior wall in the prepyloric region into

which the normal mucosa dipped. Dr. Crump thought that this was not an ulcer and was probably a diverticulum. A second gastroscopy

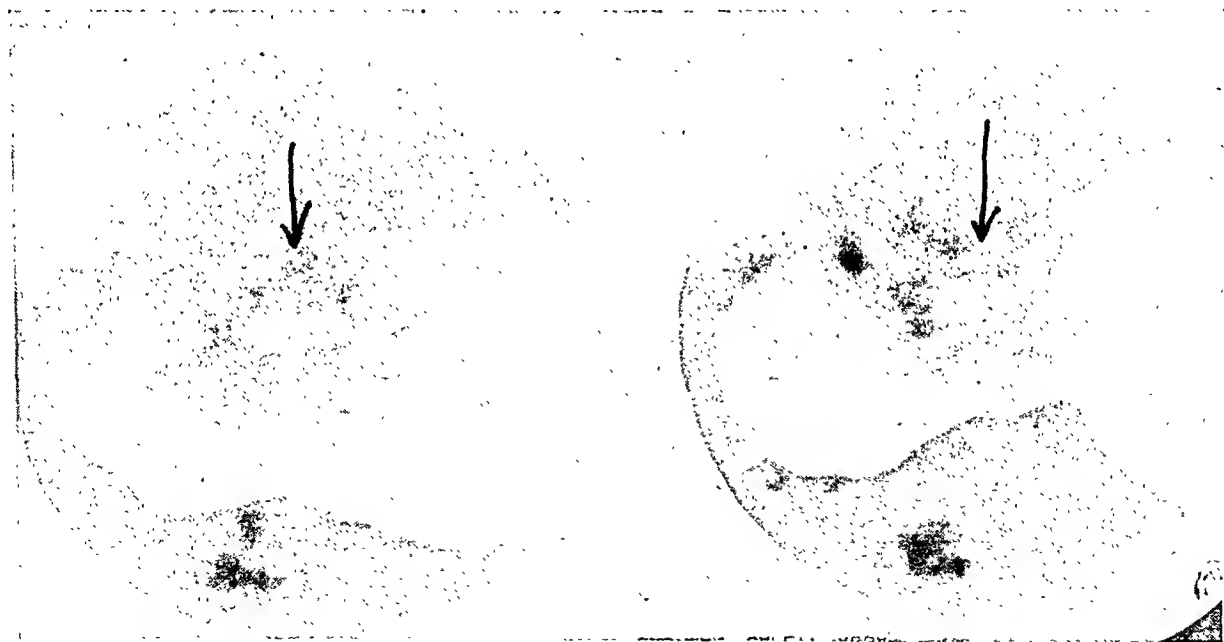


FIG. 3. Diverticulum of the lower end of the stomach. Pressure roentgenograms made May 26, 1941, disclose an oval barium shadow in the prepyloric region suggesting the crater of an ulcer. This shadow was reproduced at a second observation on July 8, 1941.

was done August 20, 1941, and the outpouching was again seen but appeared to be not quite as deep as at the first observation. The gastric mucosa appeared normal.

The patient's arthritic complaints were greatly improved following gold therapy. No digestive disturbances were recorded up to the patient's last visit on January 6, 1942.

#### COMMENT

This case illustrates the importance of pressure methods of roentgen examination of the stomach, as this diverticulum was in the posterior wall and was too shallow to be demonstrable in any other way. It also emphasizes the helpfulness of gastroscopy with roentgen examination, as the former showed clearly that the mucosa was intact and therefore that no ulcer was present. The fact that normal peristalsis flowed freely through the antrum and effaced the barium shadow should have suggested that the lesion was not an ulcer. An exact classification cannot be made without histological study. It would seem likely that this was a true diverticulum but whether it was

congenital pulsion in type cannot be determined.

#### SUMMARY

An extraluminal barium shadow in the lower end of the stomach, demonstrable only on pressure, was shown by gastroscopy to be a diverticulum.

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# MEGA-ESOPHAGUS AS A CAUSE OF MEDIASTINAL WIDENING\*

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**E**XTENSIVE mass surveys of apparently healthy adults to detect unknown cases of tuberculosis have been a major part of the services of the Bureau of Tuberculosis of the Department of Health since 1933.<sup>1</sup> This type of case finding has been greatly extended as a result of the routine chest roentgenograms of the selectees at the Army Induction Center.<sup>2,3,4</sup> Similar mass studies of adult populations are developing throughout the country so that greater and greater samples of the population are being roentgenographed for the first time.

While the detection of tuberculosis has been the prime objective of such studies, they have at the same time revealed a wealth of non-tuberculous conditions demonstrable in the chest roentgenogram that has been of the greatest interest. For, as in incipient tuberculous lesions, the discovery of many of the non-tuberculous abnormalities has resulted in therapy or corrective measures that have benefited the individual.

This report will deal with 11 cases in which the initial roentgenogram suggested the presence of a mega-esophagus subsequently verified by the barium meal. This condition has in the past fallen mainly within the province of the gastroenterologist and internist. When the dilatation becomes sufficiently marked to project beyond the cardiac or sternal border it presents a rather characteristic appearance on the chest roentgenogram. It therefore assumes an important position in the differential diagnosis of mediastinal abnormalities particularly to physicians interested in chest diseases and to those reading survey roentgenograms.

A review of the literature is confusing in that cases appear classified under a variety of terms. The term "cardiospasm" was first

introduced by Mikulicz<sup>8</sup> in 1888 who described the dilatation as due to an actual spasm of the cardiac sphincter. Sturtevant<sup>11</sup> reviewed the literature up to 1933 and defined "cardiospasm" as the "common name used for a condition in which, without demonstrable obstructive pathologic change, and usually without pain, food does not pass readily from the esophagus into the stomach, but is held in the esophagus which in the majority of cases, undergoes dilatation, sometimes extreme."

It has been noted by many observers that the marked dilatation seen in simple, so-called non-organic "cardiospasm" is rarely seen in organic stenosis. No benign or malignant stricture causes dilatation even approaching that produced by "cardiospasm." Some authors have predicated vagus nerve involvement by trauma, lead poisoning, infection, etc., as an explanation for the esophageal ectasia. Others have suggested a congenital tendency to idiopathic dilatation, perhaps similar to Hirschsprung's disease. Finally, denying the existence of a sphincter, the possibility was suggested that the diaphragmatic muscle might cause the obstruction, acting as a pinchcock on the cardia. Recently Etzel<sup>5</sup> proposed a chronic vitamin B<sub>1</sub> deficiency as the basic cause for this condition as well as for megacolon and mega-ureter.

In early studies in 1913, A. F. Hurst<sup>6</sup> stated that the obstruction was caused by absence of relaxation of the sphincter which normally occurs when, in the act of swallowing, a peristaltic wave reaches it. He proposed the use of the term achalasia, meaning absence of relaxation of the cardiac sphincter. He felt that achalasia was not purely functional, a theory widely held, but that investigation would prove that it was the result of organic change involving the neuromuscular control of the sphincter.

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Rake<sup>10</sup> later demonstrated round cell infiltration in Auerbach's plexus at the lower end of the esophagus in early cases and degenerative changes resulting in more or less complete disappearance of the ganglion cells in late cases. Several investigators have confirmed this finding, but contradictory opinions are still held.

A very complete and scholarly presentation of the anatomy of the cardiac orifice of the stomach was recently presented by Lendrum.<sup>7</sup> He was unable to demonstrate a true sphincter or increased local musculature or elastic tissue, but he stated that the last inch of the esophagus acted in that capacity. He gave a complete description of the pathologic findings in 13 cases of "cardiospasm." In no case was there organic narrowing of the neck or scarring around it. No thickened sphincter or hypertrophic oblique muscle was found, nor was there sufficient evidence to implicate the diaphragm in causing compression. In 10 of the 13 cases where adequate sections could be obtained, the vagi were normal. In every case, however, there was a striking loss or complete absence of the ganglion cells from the myenteric plexus.

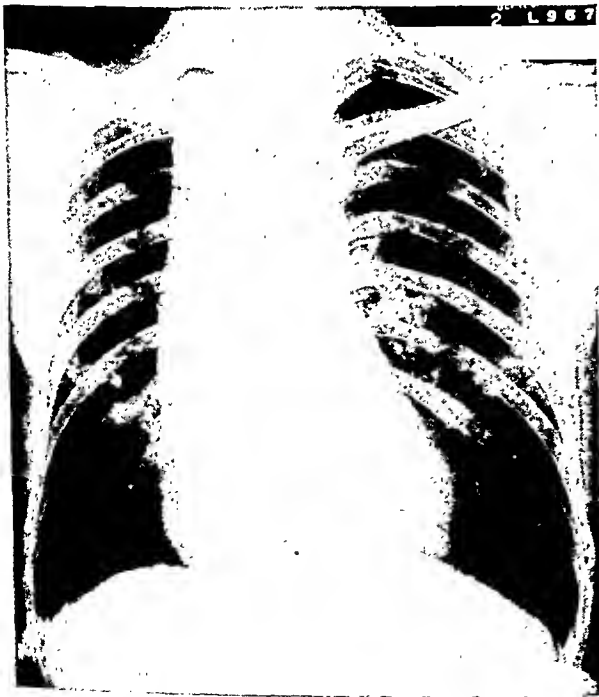


FIG. 1. Case I.



FIG. 2. Case I.

#### REPORT OF CASES

**CASE I.** M. M., a white male, aged thirty-seven, was rejected by the Armed Forces Induction Station for "cardiospasm." He gave a history of difficulty in swallowing which dated back to 1937 following an attack of pneumonia. There were frequent attacks of vomiting. A diagnosis of "cardiospasm" had been made at a hospital in 1937. Physical examination showed parasternal dullness on the right. The roentgenogram showed a diffuse widening of the mediastinum beginning at the extreme thoracic inlet at D<sub>2</sub> with a curved border proceeding straight down parallel to the sternum and occupying the inner half of the right chest. At the dome of the diaphragm, the density curved to the left obscuring the cardiophrenic angle. There was an air pocket at the extreme upper portion with a mottled stippled appearance in the upper third of the density (Fig. 1). Barium filling showed a narrowing at the cardiac end with a markedly dilated esophagus extending straight down and then assuming a tortuous appearance lying across the dome of the diaphragm (Fig. 2). The esophagus measured 7 cm. from the right border to the mid-point of D<sub>7</sub>.

**CASE II.** M. T., a Negro female, aged thirty-seven, was referred to one of the district clinics

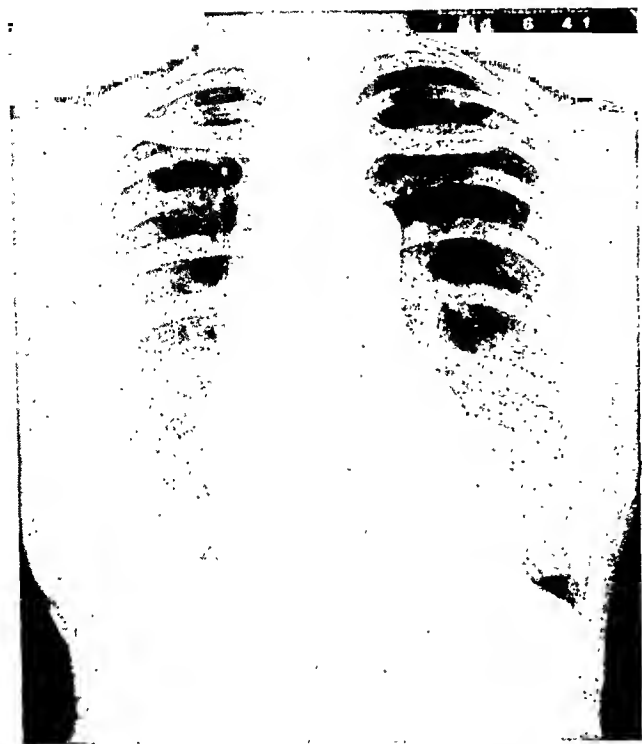


FIG. 3. Case IV.

by her private physician because of cough and expectoration of three weeks' duration. Examination was negative but roentgenoscopy and roentgenographic examination revealed a diffuse mediastinal widening with a density on the right, separate from the heart shadow. She was recalled on the suspicion of an esophageal dilatation. Further questioning revealed a history of some dysphagia, nausea, and occasional postprandial vomiting for the past seven years. The roentgenogram revealed the density to begin at about  $D_3$ , without a visible air pocket or fluid level. The density was homogeneous without any stippling and extended straight down reduplicating the cardiac contour and traversing and faintly obscuring the cardiophrenic angle. The density was widest at  $D_9$  and measured 5.5 cm. from the right border to the middle of the vertebra. Barium studies demonstrated the "cardiospasm" and mega-esophagus.

CASE III. S. F., a white male, aged thirty-five, was rejected by the Induction Station for a known "cardiospasm." He had been well up to the age of fourteen when he began to regurgitate food after almost every meal. A diagnosis of "cardiospasm" and mega-esophagus was made, and at the age of twenty-one the anterior vagus nerve was sectioned with only slight relief. Physical examination revealed nothing of note. The roentgenogram revealed a homogeneous

density beginning at  $D_3$  and extending downwards reduplicating the cardiac contour and obscuring the cardiophrenic angle. There was a faint suggestion of an air pocket but no fluid level was visualized. The density measured 5 cm. from the middle of  $D_8$  at its widest point. Barium studies showed a high grade "cardiospasm" with a typical mega-esophagus.

CASE IV. L. C., a white female, aged fifty, was referred for examination as a teacher-applicant. There were no complaints or abnormal physical signs but the roentgenogram (Fig. 3) showed a diffuse widening of the mediastinum beginning at  $D_3$  with a soft convexity outwards and downwards. At the upper portion was an air pocket with a questionable fluid line at the level of the clavicles. The upper third of the density had a stippled appearance. The density measured 5 cm. at its greatest width to the middle of  $D_7$ . The patient was recalled for further study with the tentative diagnosis of mega-esophagus and gave a history of intestinal upset about ten years previously. Studies done at that time had revealed a dilated esophagus. Barium studies at this clinic (Fig. 4 and 5) showed that the apparently even widening was actually hour-glass, the right hilar density bridging the upper and lower convexities. The esophagus was evenly widened to  $D_{10}$  and became tortuous beyond that point, lying across the dome of the

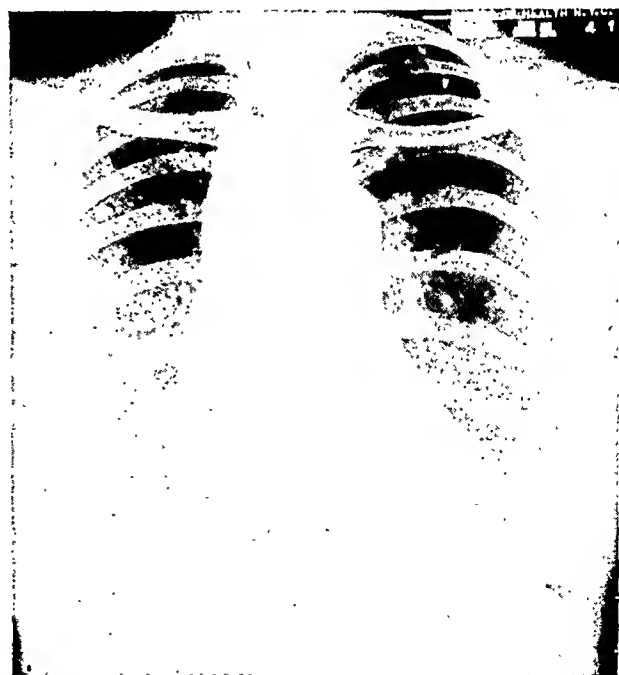


FIG. 4. Case IV.

diaphragm. On the right lateral view (Fig. 6) a definite fluid level is noted in a goblet-shaped, stippled area lying between the vertebral column and the trachea which is displaced forwards.

CASE V. N. P., a white male, aged thirty-five, was rejected by the Induction Center because of an unusual mediastinal density. He gave a history of "food getting stuck frequently," without vomiting or weight loss for the past five to six years. Physical examination was entirely negative. The roentgenogram showed a



FIG. 5. Case IV.

slight widening of the right upper mediastinum beginning at D<sub>3</sub>. Inspection of the 4×10" roentgenogram taken at the Induction Center revealed a suspicion of a fluid level at the sternoclavicular junction with an air column above. Maximum width of the density was 4 cm. at the middle of D<sub>6</sub>. There was an obscured cardio-phrenic angle without reduplication of the cardiac contour. Barium studies revealed a "cardio-spasm" with a mild degree of mega-esophagus.

CASE VI. M. D., a white male, aged thirty-nine, was rejected by the Induction Center because of the discovery of an unusual mediastinal density. He gave a history of difficulty in eating



FIG. 6. Case IV.

large meals, fullness and the necessity for drinking large quantities of water with his meals. Physical examination was negative. The roentgenogram (Fig. 7) showed a mediastinal widening to the right originating at D<sub>2</sub>. There was a



FIG. 7. Case VI.



FIG. 8. Case vi.

suggestion of a fluid level at D<sub>3</sub>. The outer density reduplicated the right cardiac contour and crossed the diaphragm obscuring the cardiophrenic angle. The density was widest at D<sub>6</sub>, measuring 5.5 cm. to the middle of the vertebral body. No stippling was seen on the posteroanterior view. The lateral projection (Fig. 8) showed a goblet-shaped, stippled density lying between the vertebral column and the trachea which was convex anteriorly. Barium studies revealed a high grade "cardiospasm" with a marked mega-esophagus.

CASE VII. P. A., a white male, aged twenty-two, was first seen in a union survey. He gave a history of having been under observation in a hospital three years previously, was told that he had ulcers of the stomach and was advised to go on a milk and cream diet. No roentgenograms were taken at that time. For the past three or four years he complained of recurrent vomiting immediately after meals, with occasional attacks of left upper abdominal pain and marked belching which usually preceded the vomiting spells. He had lost about 7 pounds in the past year. There had been two occasions in the past year when very black stools were observed. Physical examination was essentially negative. The roentgenogram (Fig. 9) showed a large homogeneous density in the upper half

of the right chest extending for a distance of about two-thirds of the transverse diameter of the right chest with a sharp convex outer margin. The border was continuous below with a density reduplicating the cardiac contour and traversing and obscuring the cardiophrenic angle. The widest diameter of the upper rounded portion was 10 cm. to the middle of D<sub>4</sub>. Lower down at D<sub>8</sub>, the diameter was 7.5 cm. The upper widened portion presented a stippled appearance. A diagnosis was made of mega-esophagus with a diverticulum-like dilatation in the upper portion. Roentgen studies after a barium meal confirmed the diagnosis. With the first swallow of a thick barium mixture the left portion of the upper density filled readily. The right-sided rounded portion of the density filled only after the barium reached the middle third of the esophagus (Fig. 10 and 11).

The patient was hospitalized for further study. The following is a verbatim report of the roentgen findings. "Examination of the alimentary tract by means of a barium meal shows evidence of enormous dilatation of the entire esophagus which in its upper third courses to the right of the spine and produces the shadow of increased density seen on the chest film. A large amount of retained food particles and secretion is present in the esophagus. During the thirty minute observation period none of the barium entered the stomach. The cardiac end is

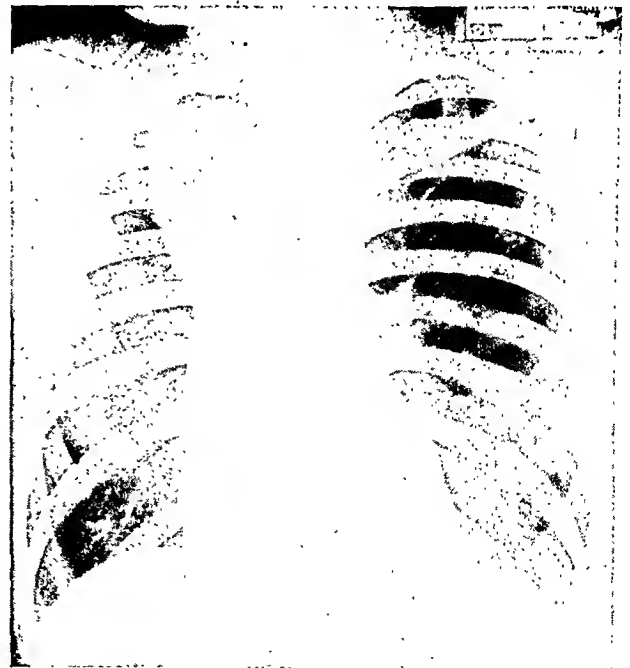


FIG. 9. Case vii.

smooth in contour. No evidence of malignancy can be demonstrated, although this possibility cannot be entirely excluded. Six hours after the ingestion of the barium none of the opaque medium has entered the stomach. Twenty-four hours later barium is seen outlining most of the colon.

"Impression: The findings indicate marked dilatation of the entire esophagus, probably on the basis of a 'cardiospasm.' The obstruction at the cardiac end is of a very high degree."

CASE VIII. H. A., a white male, aged seventeen, was rejected by the Induction Center for "cardiospasm." Two years previously, while at a hospital for minimal tuberculous lesion, he was informed of this condition. He complained of a choking sensation during his meals for which he has been taking belladonna with slight relief. The roentgenogram showed a slight mediastinal widening beginning at D<sub>4</sub> which followed the cardiac contour and was widest at D<sub>10</sub>—5 cm. Administration of barium demonstrated a widened esophagus with an hour-glass shape.

CASE IX. T. J., a white male, aged twenty-four, had been roentgenographed three years previously and had been told that the findings were negative. He was drafted in 1941 and, fol-



FIG. 11. Case VII.

lowing the onset of a respiratory infection, was admitted to the station hospital. Roentgen studies revealed a dilated esophagus. He was given a medical discharge and admitted to the Central Chest Clinic for further study. He had no digestive disturbances but did confess to occasional vomiting which occurred sometimes at night or after eating too quickly. The roentgenogram showed a mediastinal widening beginning at D<sub>2</sub>, and becoming progressively more marked up to D<sub>10</sub> where it was 7 cm. A definite fluid level was noted at D<sub>3</sub> and stippling was present throughout the visible portion of the esophagus. Roentgen studies after a barium meal confirmed the presence of a markedly dilated esophagus.



FIG. 10. Case VII.

CASE X. C. J., a Negro male, aged twenty-eight, was referred to one of the district clinics for cough, expectoration, and dyspnea. He gave a history of difficulty in eating for the previous sixteen years and stated that he had to drink water or milk with his meals to get the food down. A diagnosis of widened esophagus was made at a hospital six years before. The initial roentgenogram taken at the district clinic showed a moderate dilatation of the lower mediastinum. On further examination one month later, there was diffuse widening beginning at

D<sub>2</sub> and becoming progressively wider until D<sub>11</sub>—8.5 cm. at the diaphragmatic level. Barium studies showed a fish-hook type of mega-esophagus with a thin trickle of barium through the cardia.

CASE XI. S. S., a Negro male, aged twenty-eight, was rejected by the Induction Center for "cardiospasm." For the past one and one-half years, he had suffered from cough followed by regurgitation and vomiting immediately after eating. No pain or weight loss had been noted. A diagnosis of "cardiospasm" had been made at a hospital with unsuccessful attempts at dilatation. The roentgenogram showed a diffuse mediastinal widening beginning at D<sub>2</sub> and widest at D<sub>7</sub>—8.5 cm. From that point down it became somewhat narrower. A fluid level was clearly seen at D<sub>3</sub> with a suggestion of stippling. On the lateral view, the trachea was convex anteriorly. Roentgen studies after a barium meal showed an enormously dilated esophagus coiled and invaginated in the lower half and appearing at the left of the sternum.

#### DISCUSSION

There were 11 cases in this series, 9 males and 2 females, ranging in age from seventeen to fifty. It is not possible to draw any conclusions from the age or sex distribution inasmuch as the majority (7) were diagnosed among rejected draftees, all male, and of a selected age group. The others were found as follows: 2 on routine chest roentgenograms taken in the course of a survey, and 2 in a consultation chest clinic referred by their private physician for pulmonary complaints. Among the 11 cases, there were 8 whites and 3 Negroes.

One of the most interesting features in the study of mega-esophagus is the marked disproportion between the relative paucity of the complaints and the good general condition of the patient on the one hand, and the large size of the esophagus on the other. The complaints dated back to from one and one-half years to as long as twenty-one years. There was no definite recollection in most cases of any precipitating cause for the onset of symptoms. The symptoms were varied but referable to the upper digestive tract. In only 1 case was there only

a "mild intestinal upset" which had led to the diagnosis. Most cases had difficulty in swallowing, nausea, and vomiting either occasionally or after every meal. Difficulty in eating large meals was a prominent complaint but pain was rarely mentioned. Many authors have stressed the onset of complaints as following some psychic trauma. In Plummer and Vinson's large series,<sup>9</sup> they noted an inverse relationship between psychoneurosis and dilatation of the esophagus. Patients with "cardiospasm" without esophageal dilatation were frequently of psychoneurotic type. Concerning "cardiospasm" with dilatation, they believe that "contrary to general belief, cardiospasm is not a psychoneurosis, and patients suffering from it are usually calm and well balanced with normal nervous systems."

In true mega-esophagus, the variation in the clinical pattern depends upon the ability of the esophageal musculature to overcome the obstruction. This has been compared to cardiac disease in its compensated and decompensated states.<sup>7</sup> In moderate cases, there may be only slight dilatation with thickening of the muscular walls, most particularly the circular muscles. There is also thickening of the circular elastic fibers. If long continued and severe pressure from within continues, other changes may occur. There may be enormous dilatation of the esophagus, with stretching lengthwise and thinning of the muscle. In severe cases, the lower half of the esophagus telescopes upon itself, the muscle fibers are torn and become fibrotic and the elastic fibers thinned. In occasional cases, the mucosa may herniate through the remnant of the muscular wall in the form of a diverticulum (Case VII).

Reference has been made to several diagnostic roentgen features which are here more fully discussed and which will aid in the differential diagnosis of this condition from other causes of mediastinal widening.

1. *Diffuse Widening of the Mediastinum.* The shape of the mega-esophagus depends largely upon the degree and location of the



dilatation. In addition to the diffuse widening, an elongation takes place which may best be described as the coiling on the floor of a slack rope suspended from the ceiling. The widening of the mediastinum is usually seen beginning at the thoracic inlet or just below. In 5 cases, it began at D<sub>2</sub>, in 4 cases at D<sub>3</sub>, at D<sub>4</sub> in 1 case, and in Case VII an enormous diverticulum was present at the extreme thoracic inlet. The degree of widening is difficult to measure since the greatest visible dilatation takes place to the right of the sternal or cardiac border, and because the left border of the esophagus is lost in the cardiac density. It was not considered practical to measure the esophagus after filling with barium since it was noted that its size, then, bore no constant relationship to that in a resting state. With a marked "cardiospasm," the esophagus could dilate to almost double its size to retain the entire barium meal, with a concomitant stretching and thinning of the wall. The largest width of the esophagus on the routine roentgenogram was measured from the right border to the center of the appropriate vertebral body. This varied from 4 cm. at D<sub>6</sub> in Case v to 8.5 cm. at D<sub>7</sub> in Case XI and D<sub>11</sub> in Case x.

2. *Fluid Level.* A definite level was found in 4 of the 11 cases traversing the tracheal column of air at the level of the clavicles. It depended on recent eating, drinking, and swallowing of air for its presence, and when found was pathognomonic. While present in only 4 cases, it is most important as a diagnostic clue in the absence of marked dilatation sufficient to cause obvious widening of the mediastinal shadow.

3. *Stippling.* In the upper esophagus lying to the right of the sternum, there is occasionally seen a peculiar stippled, marbled, or mottled density. This is due to the contrast created by the mixture of air and food contents. On the right lateral view, this may be demonstrated as a goblet-shaped stippled density lying between the vertebral column and the trachea displaced anteriorly. In 4 of the 11 cases, stippling was a pronounced feature.

4. *Apparent Widening of the Cardiac Contour.* On a routine roentgenogram with normal exposure the right inferior border of the dilated esophagus may give the impression of an enlarged cardiac silhouette on the right and with greater exposure, an apparent reduplication of the cardiac contour is seen. This was present in all but one case which showed the least degree of widening. In addition, in a number of the cases a superimposed density was seen behind the cardiac shadow to the left of the midline. This could best be demonstrated on a roentgenogram with slightly increased penetration and consisted of the redundant lower portion of the esophagus lying on the dome of the diaphragm.

5. *Obliteration of the Cardiophrenic Angle.* In all cases the dilated esophagus, after following the cardiac contour, crosses to the left, the redundant esophagus obscuring the cardiophrenic angle.

In every case, complete barium studies were done to demonstrate the "cardiospasm," stomach, and small bowel. This is very important in order to differentiate between mega-esophagus and congenitally short esophagus with thoracic stomach. The redundant lower esophagus associated with mega-esophagus after filling with barium usually shows incisurae and peristaltic patterns almost indistinguishable from the stomach itself. It is therefore necessary to complete the barium studies to rule out a thoracic stomach.

#### SUMMARY

1. Mega-esophagus may be diagnosed in the course of roentgen surveys of the chest.

2. Eleven cases have been presented, all of which were diagnosed before roentgen studies with the barium meal.

3. The important diagnostic points were found to be diffuse widening of the mediastinal shadow, fluid level at the level of the clavicles, apparent widening or reduplication of the cardiac contour, stippling of the upper third of the density, and obliteration of the cardiophrenic angle.

4. In suspected cases, complete roentgen

studies with the barium meal should be done including visualization of the stomach and small bowel, to differentiate this condition from congenital anomalies of the esophagus and stomach.

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# UNUSUAL TYPE OF INVERSION OF THE STOMACH ASSOCIATED WITH DIAPHRAGMATIC EVEN-TRATION AND OTHER ANOMALIES

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**I**NVERSION of the stomach, according to Bockus,<sup>3</sup> "is characterized by an orad position of the greater curvature together with extreme left lateral position of the cardia. The duodenal cap is downward . . ." He goes on to say that "This anomaly may be associated with annoying dyspeptic symptoms and bowel dysfunction."

## REPORT OF CASE

*Present Illness.* A soldier, aged twenty-four, was admitted to the Station Hospital for study complaining of "gas on the stomach," anorexia, occasional vomiting, nervousness, and slight post-prandial left upper quadrant pain which was relieved by belching and lying down after meals. He vomited four or five times a week; the vomitus was free of blood but contained food just previously eaten. There was no constipation or obstipation.

*Social History.* He has had an unhappy family background, and has taken to excessive smoking and drinking for the past two years. He admits that he has had difficulty in adjusting himself to Army life and was demoted for inefficiency, his symptoms being markedly aggravated directly after this event.

*Physical Examination.* Upon admission to the hospital, this patient appeared well nourished and not acutely ill. He was both nervous and apprehensive. The examination of the cardio-respiratory system was negative. An old operative scar was present in the right lower quadrant. The abdomen was normal except for a rather firm mass, later shown to be the right kidney, which was felt near the cecum.

*Laboratory Findings.* Red and white blood cell counts were within normal limits. Urinalysis and serological examination were negative. Free and total gastric acidity was within normal range. Occasional occult blood was noted in the stools.

*Roentgen Findings.* Roentgenographic and roentgenoscopic examinations of the chest revealed a markedly elevated left dome of the diaphragm, the apex being at the level of the

fourth interspace anteriorly, on deep inspiration (Fig. 1). The outline of the diaphragm was smooth and a large gas bubble was noted, which was later shown to be the Magenblase. In the Trendelenburg position, the bubble did not rise above the diaphragm, even on deep abdominal pressure. The left dome of the diaphragm moved approximately 1 inch and its excursions were diminished as compared to the right. No paradoxical movements were noted.

Barium meal examination showed the esophagus to be in the midline; it appeared normal. The cardiac sphincter and cardiac end of the stomach appeared to be at the twelfth dorsal vertebra, while the greater curvature of the stomach was situated at the level of the sixth dorsal vertebra, and fitted closely beneath the elevated left dome of the diaphragm (Fig. 2). The stomach assumed an inverted fish-hook appearance, curving from right to left with the antrum and duodenal cap pointing downward and situated in the left upper quadrant. The

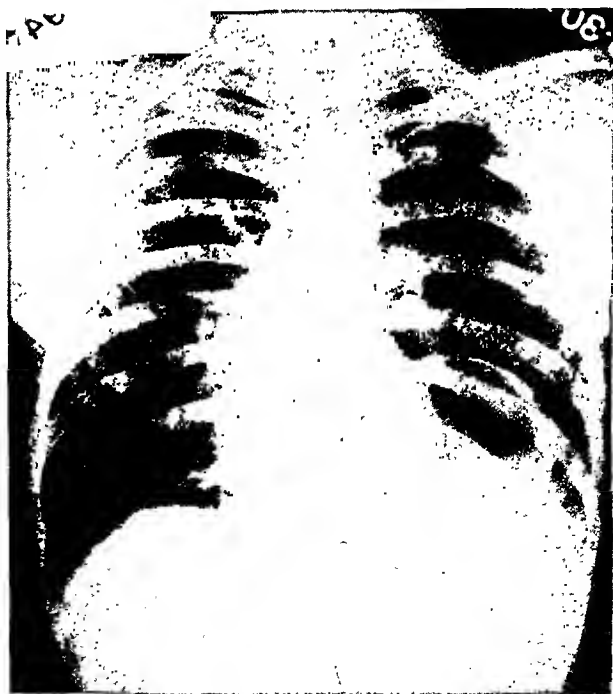


FIG. 1. Marked elevation of the left dome of the diaphragm and large stomach bubble below it.



FIG. 2. Complete inversion and reversal of the stomach with the cardiac end (C) situated in the left side of the abdomen at the level of the twelfth dorsal vertebra, the greater curvature margin (GC) fitting under the elevated left dome of the diaphragm, and the duodenal cap (D) also in the left side at the level of the eleventh dorsal vertebra.

duodenal sweep assumed a normal "C"-shaped curve. With the exception of a few loops of the terminal ileum, almost all of the small bowel appeared in the left side of the abdomen. At six hours (barium water meal used) the stomach was empty and the head of the meal was at the mid-transverse colon. It was noted that the cecum was situated high in the abdomen (Fig. 3) and that the terminal ileum appeared long and dilated.

In the barium enema examination the barium entered the rectum and passed around the cecum without any interference. It was noted that the transverse colon extended diagonally down across the abdomen and the usual well defined hepatic flexure was absent. The tip of the cecum was situated at the level of the crest of the ilium. The colon exhibited a normal degree of mobility throughout. After evacuation a small quantity of barium remained in the colon.

Intravenous Pyelogram. The left kidney appeared normal in size, shape and position; the renal pelvis and calyces were well delineated. In the erect position the left kidney shifted down-

ward approximately 2 inches. Excretion of the opaque medium was excellent. The right kidney was small as compared to the left, and was situated low in the abdomen, the upper pole being at the level of the upper border of the fourth lumbar vertebra with the lower pole extending down to the first sacral segment; only the superior major calyx was well outlined. The right ureter was fairly well delineated and did not appear redundant or looped. In the erect position, the right kidney descended approximately  $1\frac{1}{2}$  inches. Excretion of the opaque medium was good (Fig. 4). It can be reasonably assumed, with the information at hand, that the right ureter is short and the low position of the right kidney is not due to ptosis but to arrest in its upward migration to the usual lumbar site.

Final Roentgen Diagnosis. (1) Eventration of the left dome of the diaphragm; (2) complete inversion of the stomach; (3) abnormally rotated stomach, the antrum and duodenal cap being situated in the left upper quadrant; (4) incomplete descent of the cecum; (5) simple iliac ectopia of the right kidney.

#### COMMENT

It is my opinion and that of others who



FIG. 3. Six hours after ingestion of the barium and water meal. Illustrates diagonal direction of the transverse colon, lack of hepatic flexure, and high position of the cecum.

have had closer clinical contact with this patient that his complaints were psychogenic in origin rather than due to the many anomalies present. This is borne out by the cases that Ekstrom<sup>5</sup> reported in which she stated, "Neither of the cases had noteworthy symptoms and the discovery of the abnormality was an incidental finding."

A psychiatric study of this patient showed him to be sufficiently maladjusted and mentally unstable as to make him unfit for military service. He was later discharged from the Army.

#### INCIDENCE

Gross abnormalities of the stomach are rare and reports of inverted or "upside-down" stomachs are exceedingly rare. Bockus makes mention of this condition in his recent text, while nothing is said of this anomaly in the standard treatises on the gastrointestinal tract by Eusterman and Balfour,<sup>6</sup> Barclay,<sup>1</sup> Rehfuess,<sup>10</sup> and oth-

ers. Feldman<sup>7</sup> states that he saw 2 cases in approximately 15,000 gastrointestinal examinations. Rhinehart and Rhinehart<sup>11</sup> reported 2 cases and Ekstrom,<sup>5</sup> 2 cases. A search through the literature of more than twenty years fails to reveal any others. The most interesting part of the case herein described is that the stomach is not only

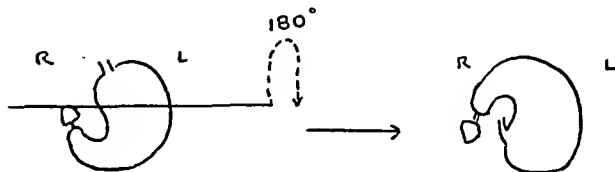


FIG. 5. Diagram illustrating Rhinehart and Rhinehart's conception of the mechanism of gastric inversion of the type that they described.

inverted but reversed, the pylorus and duodenal cap being situated in the left side of the abdomen (Fig. 2), while in the cases already reported the pylorus and duodenal cap are in the right side (Fig. 5).

#### EMBRYOLOGY

All writers agree that inversion of the stomach is a congenital anomaly and the fact that it is usually associated with other congenital defects adds weight to this contention. There is considerable difference of opinion as to the cause of, and as to the forces that come into play in the production of various normal developmental rotatory phenomena of the gastrointestinal tract, such as the 90 degree rotation of the stomach on its long axis, and the 180 degree counterclockwise rotation of the small bowel around the superior mesenteric artery. One could hardly expect, then, a precise description of the developmental process of this rare abnormality, inverted stomach.

Rhinehart and Rhinehart surmised that this anomaly, of the type they and others described, was the result of rotation of 180 degrees of the stomach around its transverse axis (Fig. 5). I showed the case under consideration to Dr. Corner<sup>4</sup> and his associates at the Carnegie Institute of Embryology. They were rather reluctant to offer



FIG. 4. Intravenous pyelogram (five minute film). Demonstrates low position and small size of the right kidney. Subsequent pyelograms show the right ureter more clearly.

an opinion, since nothing is known as to the mesenteric and ligamentous attachment of the stomach and neighboring viscera. They suggested, though, that a likely explanation was the following: At some time before the duodenum was fixed, when the embryo was between 30 and 35 mm. in size, the stomach was either pushed or pulled up in the left

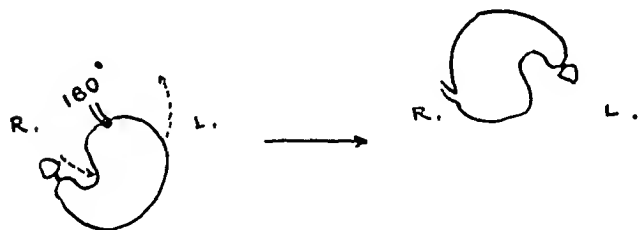


FIG. 6. Diagram illustrating mechanism of gastric inversion of the type described by the author. See text.

upper quadrant to fit under the elevated left dome of the diaphragm with the cardiac end remaining stationary and acting as a fulcrum (Fig. 6).

Associated with inversion of the stomach, eventration of the left dome of the diaphragm was seen. No attempt will be made to discuss this subject since the articles of Bayne-Jones,<sup>2</sup> Korns,<sup>8</sup> Reed and Borden<sup>9</sup> are exhaustive and comprehensive. Interestingly enough, in both of Ekstrom's cases, inversion of the stomach was associated with eventration of the left dome of the diaphragm and in one of Rhinehart and Rhinehart's cases the left dome of the diaphragm was absent. What part this anomaly plays in inversion of the stomach is not known. Most likely, it is a corollary of the dictum, "Where there is one anomaly, others are likely to be found."

#### SUMMARY

1. A case of complete inversion of the stomach is presented.

2. This case differs from all the other cases reported in that the stomach is not only inverted but reversed, the antrum and duodenal cap being situated in the left upper quadrant. In the other cases reported, the antrum and duodenal cap are located well to the right of the midline.

3. This anomaly was associated with other congenital abnormalities: eventration of the left dome of the diaphragm, incomplete descent of the cecum, and iliac ectopia of the right kidney.

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# LESIONS OF THE DIAPHRAGM

## WITH SPECIAL REFERENCE TO EVENTRATION AND A REPORT OF THREE CASES

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THE statistical value of the summarized findings in the consecutive examination of a large number of chest roentgenograms at an Armed Forces Induction Station is unquestioned. This is particularly true when one considers certain variations from normal and minor congenital defects which often have no clinical symptoms and are therefore seldom followed to the autopsy table.

In most of the recently reported series of diaphragmatic lesions, about 80 per cent have been esophageal hiatus hernias.<sup>5,6</sup> It is true that these hernias can sometimes be diagnosed on the routine chest roentgenogram, but this is uncommon, and none of this type are included in this report. In fact, we must admit that not a single case of esophageal hiatus type hernia was diagnosed from the chest roentgenogram alone during the examination of this group of roentgenograms.

There were 38 cases of diaphragmatic lesions found during the examination of 412, 149 chest roentgenograms. Of these, only 3 were considered from the roentgen standpoint alone to be true diaphragmatic hernias. The first of these was a congenital absence of the posterior portion of the left diaphragm. The stomach, splenic flexure of the colon, and several loops of small intestine were herniated into the thoracic cage. The second was a congenital hernia through the right foramen of Morgagni. The third was a traumatic hernia through the left hemidiaphragm following an inflammatory necrosis. The remaining 35 cases were congenital eventrations of the diaphragm, 30 occurring on the left and 5 on the right.

Since the beginning of routine roentgen examinations, eventration of the diaphragm, among other abnormalities of the human anatomy, has become rather com-

monplace. It is generally conceded to be a congenital condition since it has been found in the newborn. Clinical findings include an elevation of the diaphragm with a normal regular contour. Usually the normal respiratory excursion is absent and occasionally paradoxical movements are noted. Compression of the lung on the affected side is not seen and usually the condition is asymptomatic.

Pathological examinations of true congenital eventrations have been uncommon. Degeneration of the phrenic nerve secondary to trauma, tumor growth, and cervical tuberculosis have been reported and it may well be that eventration is not a true congenital anomaly, but is the result of birth injury to the phrenic nerve.<sup>1</sup> Degeneration of the diaphragmatic musculature is apparently secondary to destruction of the phrenic nerve.

The diagnostic roentgen signs of eventration are a high position, a regular arched contour, and possible changes in the excursions due to the defective musculature.<sup>3</sup> By far the greater percentage occur on the left side. In our series of 35 cases only 5 were found on the right side.

The differential diagnosis of eventration and diaphragmatic hernia is not always easy. If the diaphragm can be completely outlined and it can be determined that all the abdominal contents are below, one may be reasonably certain that he is dealing with a simple eventration. Because the elevated diaphragm is usually very thin, even this is not always possible, and some have resorted to pneumothorax or pneumoperitoneum for differentiation.<sup>2</sup> If air passes from the abdominal cavity to the thoracic cavity or vice versa it becomes obvious that the lesion in question is a hernia.



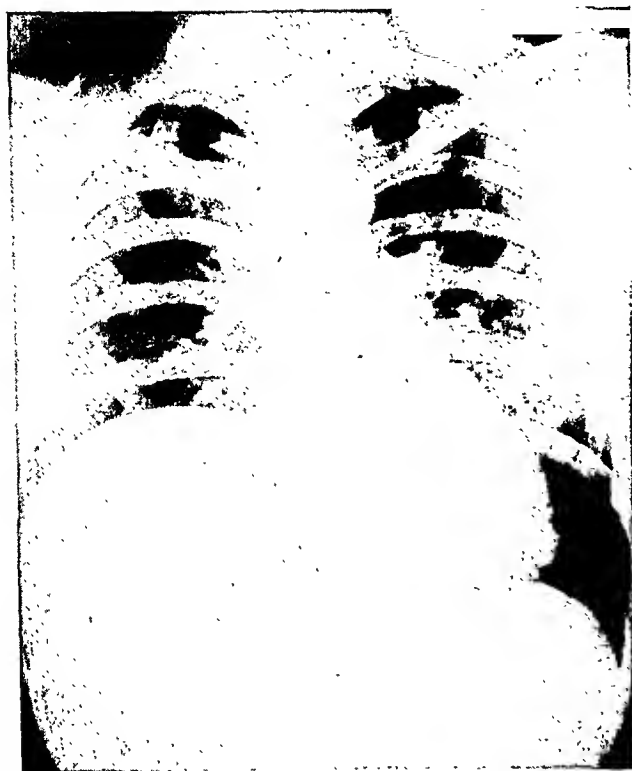


FIG. 1. Case I. Roentgenogram of the chest showing elevation of the right diaphragm to the level of

Marks,<sup>7</sup> in discussing the anatomy of the diaphragm, points out that the formation of the diaphragm and the separation of the celomic cavity into the pleural, pericardial, and peritoneal cavities is a complex process beginning in the human embryo when it is about 2.1 mm. in length. Division is not complete until the embryo is about 20 mm. in length, and the muscle fibers of the diaphragm form even later and are derived from an independent source—the fourth cervical myotome. If displacement of a portion of gut takes place before the division of the celomic cavity is complete, the misplaced loops of bowel will not be covered by a serous membrane and the hernia will not be a “true” one. If displacement occurs later, but before the muscular elements of the diaphragm have developed, the gut will

the fourth rib in front. The diaphragm is regular in outline and bears the configuration of the dome of the liver directly beneath.

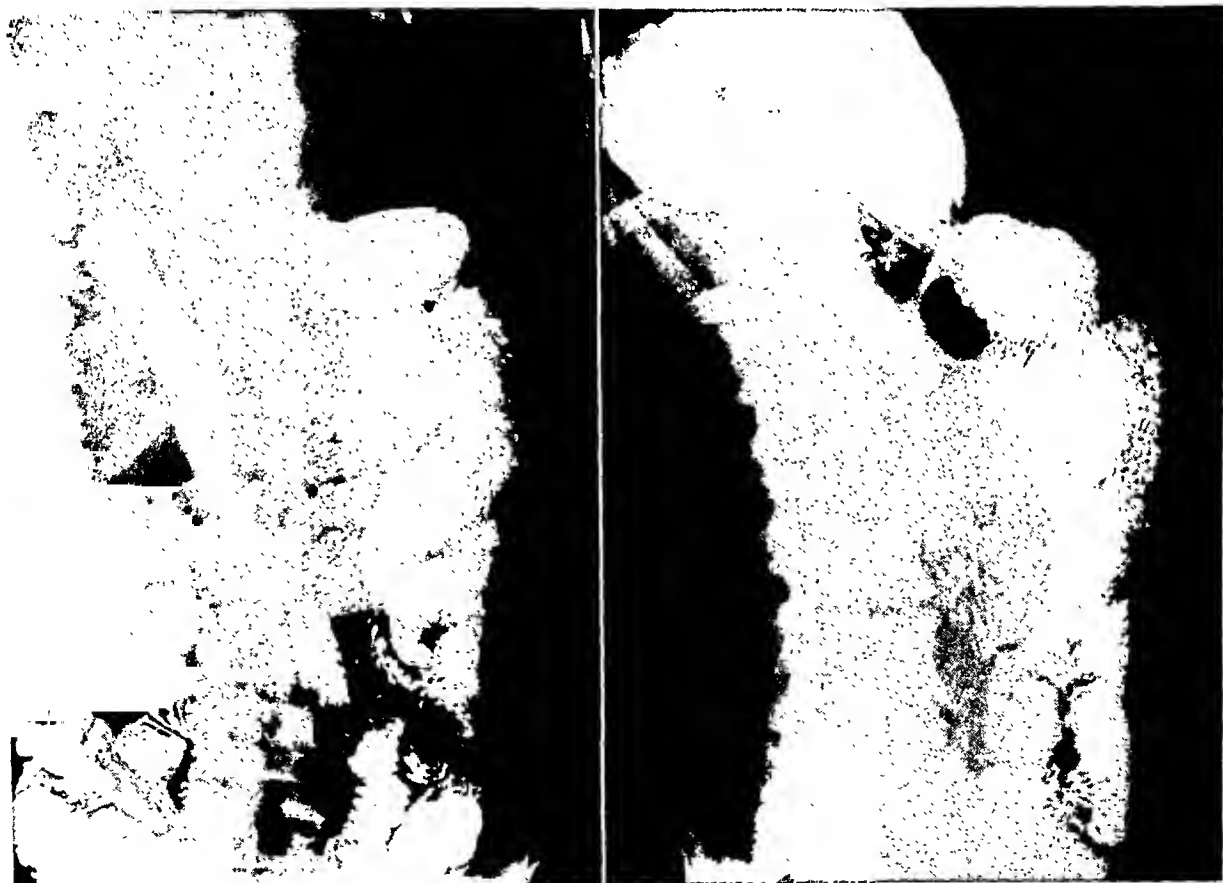


FIG. 2. Case II. Roentgenograms in the posteroanterior and oblique positions showing the body and pylorus of the stomach, and the first part of the duodenum located below the elevated right diaphragm and above the liver.



FIG. 3. Case III. Roentgenograms of the chest in the posteroanterior and right lateral positions showing elevation of the right diaphragm to the level of the second rib in front. Note the collections of gas and the bowel pattern in the right thoracic cage below the elevated diaphragm.

be covered by a serous membrane or sac and the condition will be a "true" hernia.

From the preceding discussion it becomes clear that accurate classification of diaphragmatic lesions is usually not possible. From the practical standpoint it seems to be at least necessary that we separate simple eventrations from diaphragmatic hernias. Because of the uncommon anatomical changes found in some of our cases of eventration, case histories and roentgen findings are presented.

#### REPORT OF CASES

**CASE I.** A twenty-seven year old white selectee was examined for induction into the Army on April 24, 1941. He was found to be in good health and to be physically fit except for a marked elevation of the right diaphragm. Further examination and history revealed no explanation for this condition. Roentgen examination of the chest showed an elevation of the right diaphragm to the level of the fourth rib anteriorly. The liver was located directly under the diaphragm. A diagnosis of congenital eventration of the right diaphragm was made (Fig. 1).

**CASE II.** A twenty-two-year old white selectee was examined for induction on August 26, 1943. He had no complaints and physical examination was negative except for roentgen evidence of an elevation of the right diaphragm. Further examination, including roentgenoscopy and a barium meal, revealed that the body and pylorus of the stomach, loops of small bowel, and the hepatic flexure of the colon were located directly under the diaphragm and above the liver (Fig. 2).

**CASE III.** A nineteen year old white selectee was examined for induction on September 7, 1943, and was found acceptable with the exception of a definite elevation of the right diaphragm. The chest roentgenogram revealed what appeared to be bowel located high under the right diaphragm and above the liver. Roentgenoscopic examination substantiated this and revealed the entire stomach, as well as the hepatic flexure of the colon and portions of the small bowel, located above the liver and below the diaphragm (Fig. 3 and 4).

Although most cases of eventration are asymptomatic, the abnormality becomes of clinical significance when it results in gross displacement of abdominal organs. Cardiac

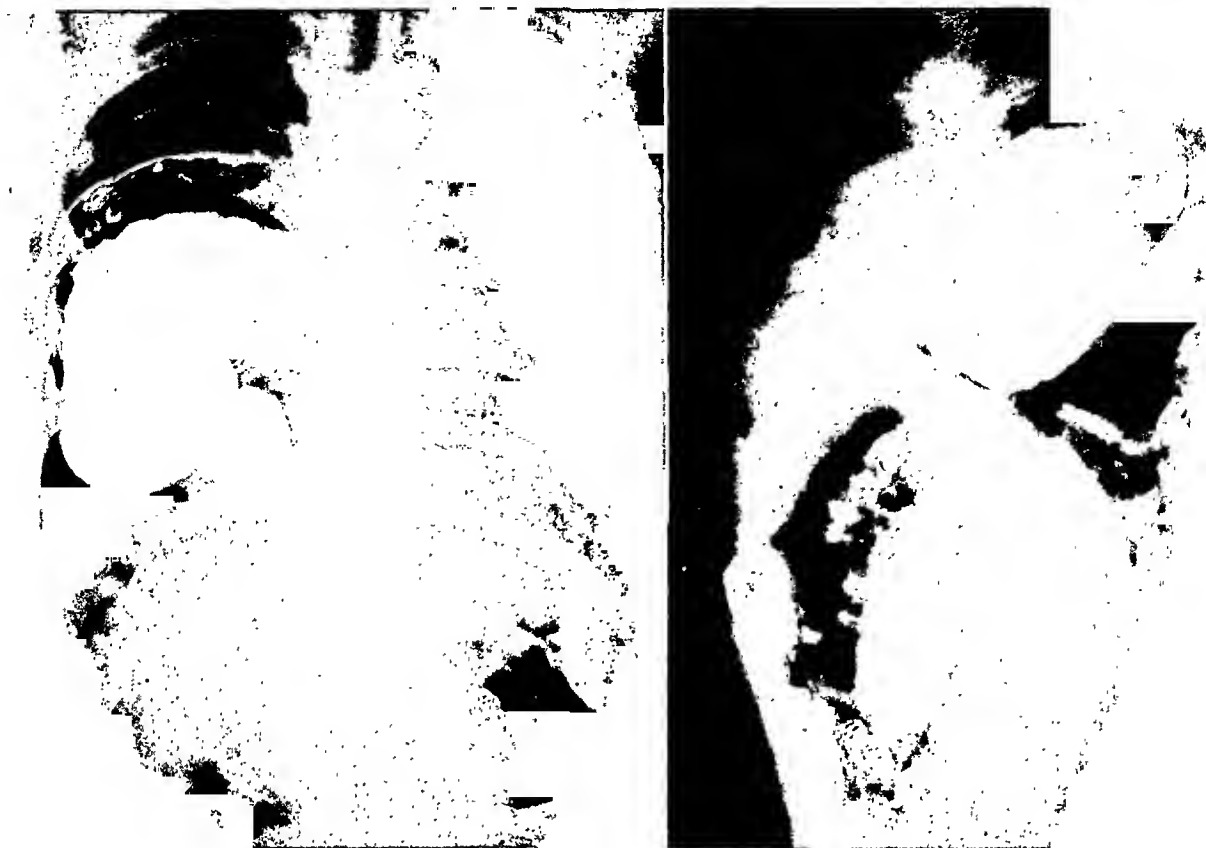


FIG. 4. Case III. Roentgenograms of the chest in the posteroanterior and right lateral positions following the administration of a barium meal. Note that the entire stomach is located directly below the elevated right diaphragm and above the liver. Later roentgenograms showed that small intestine and portions of the large intestine are also located above the liver.

displacement of more than a slight degree was not found in this series, but with an increase in age and in intra-abdominal pressure we may assume that in some cases cardiac symptoms will develop. Differentiation from diaphragmatic hernia is necessary and is sometimes difficult.

#### SUMMARY

1. Thirty-eight cases of diaphragmatic lesions were discovered during the routine examination of 412,149 chest roentgenograms.

2. There were only three cases of true diaphragmatic hernia.

3. The remaining thirty-five cases were congenital eventrations of the diaphragm, thirty occurring on the left and five on the right side.

4. Three cases of congenital eventration of the right diaphragm are presented with roentgen findings.

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## PATENT URACHUS

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THE "Consolidated Indices" of the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY (1903-1937) contains no reference to the roentgenographic demonstration of patent urachus or urachal deformities. Although Wyatt and Lanman<sup>15</sup> demonstrated a calculus in a urachus, satisfactory visualization of the complete urachal stalk has been rarely recorded in the roentgenological or urological literature. Cases of patent urachal and urachal cyst in the newborn have been previously described but these have concerned themselves essentially with the surgical treatment.<sup>5</sup> That patent urachus is not more frequently mentioned gives the impression that the condition is rare. In recent years, however, the condition has been recorded more frequently, especially in the urological journals.<sup>3,4</sup>

Garvin<sup>6</sup> demonstrated the displacement of the small bowel by the cystic mass caused by a urachal cyst. In the second case demonstrated by the same author, the urinary tract was visualized by means of 7 per cent sodium iodide injected through a patulous urachus. Although a bifid bladder was shown, the urachal stalk could not be seen in the roentgenogram made in the frontal position.

In the newborn where cystoscopy cannot be easily utilized and intravenous urography is carried out with difficulty, the use of the subcutaneous diodrast injection in distilled water for the visualization of the urinary tract is to be stressed.

This technique of subcutaneous urography has been described by Swick<sup>11</sup> and its use has been stressed by Vastine and Sampson.<sup>12</sup> Fluids are withheld for twelve hours prior to the examination. Contrast material (diodrast) consisting of 80 cc. of normal saline to which 20 cc. of 35 per cent diodrast has been added is then injected in the scapular area. Roentgenograms are

made at ten minute intervals, the examination being completed at the end of fifty minutes.

A brief review of the literature with reference to the incidence of patent urachus shows that Cross in 1935 compiled 96 cases of anomalies of the urachus. In 1937, Herbst reviewing the medical literature of the past four centuries found 148 cases of patent urachus recorded during this long period. His painstaking work included not only the type of anomaly but also the operative procedure employed and the post-operative results that were obtained. In a total of 200,000 admissions to the Children's and Infants' Hospital in Boston, the diagnosis of patent urachus was made 3 times. Among 15,000 admissions to the Brady Urological Institute of Johns Hopkins Hospital, only 3 cases presented a patent urachus. In his critical and encompassing work of the umbilicus, Cullen tabulated 62 cases of patent urachus.

In 1930, Begg<sup>1</sup> tabulated 70 cases from the literature and completed exhaustive studies of the anatomy, histology and development of the urachus in the human embryo. Its derivation in common with the upper portion of the bladder was traced from the ventral cloaca. The upper end of the bladder becomes progressively narrow as the vesical gradually develops, although it preserves on a small scale its original structure and remains attached to the umbilicus. Shortly after birth, as the bladder descends taking the urachus with it, the obliterated ends of the umbilical arteries are dragged with it. The urachus with the obliterated umbilical arteries marks the upper limit of the prevesical space. It is a remnant of the embryonic allantois which is wholly vestigial in man. The intra-abdominal portion of the allantois is designated as the urachus. The allantois including the urachus runs from the top of the

bladder to its attachment to the placenta. The urinary bladder is developed as a dilatation of the distal extremity of the allantois. If the allantois remains patent, it presents itself as the patent urachus which may be an open tube from the bladder to the umbilicus or end as a blind pouch with no connection to the urinary vesical. The abdominal portion of the allantois or the urachus situated between the peritoneum and the posterior sheath of the rectus muscles is extraperitoneal in its entire course. Begg states that the urachus extends upward from the anterior border of the bladder from a point usually 5 to 10 mm. below the apex of the vesical for a distance of 5 to 5.5 cm. The urachus, a musculotendinous structure, is situated between the transversalis fascia and the peritoneum and is movable in its lower part during the expansion and contraction of the bladder. The epithelium of the urachus may persist throughout life in numerous individuals. Hinman points out that the urachus may communicate with the bladder in one-third of all normal persons. Urine normally does not enter into the blind urachal canal, even when its open end can be probed or seen cystoscopically because of a transverse fold (Wutz's valve).

Begg<sup>1</sup> and Hinman<sup>8</sup> have described four types of anomalies of the urachus:

1. The urachus is patent throughout and is known as the complete type.
2. Patency of the urachus at its umbilical end is known as the blind external type.
3. A patent urachus at the vesical end is termed the blind internal type.
4. The ends of the urachus are closed but failure of complete obliteration of some part between the ends is present. This type gives rise to the cyst of the urachus.

Because of a deficiency of the anterior abdominal wall, the presence of patent urachus and the high attachment of the bladder in the fetus, the bladder may open at the umbilical level. Such cases have been considered as cases of simple extrophy of

the bladder. Cases of congenital patent urachus may be recognized on the day of birth, but are usually noted after the umbilicus sloughs off. Often patency of the urachus may not develop until the child is several months old and may be associated with stricture of the urethra. The association of an omphalomesenteric duct and patent urachus is very rare.

Small urachal cysts are considered of little importance and may cause few or no symptoms. While most cysts vary in size from an orange to a grapefruit, others have become large enough to be mistaken for pregnancies. These cysts are characterized by the gradual enlargement of midline of the lower anterior abdominal wall between the symphysis and the umbilicus. The differential diagnostic possibilities which must be excluded are ascites, appendiceal abscess, ovarian cyst and a distended bladder. In the examination of the urachal cavity, it is connected with the bladder or the umbilicus. At times, the urachal cavity may form an accessory or storage bladder in which a cystitis may develop as in the normal bladder. At times, it may be necessary to open and drain the accessory sac and such a mass must be differentiated from a distended bladder, ovarian cyst or a subcutaneous mass.

Various roentgenographic procedures may be utilized in the examination and differential diagnosis of patent urachus. Preliminary roentgenograms in the frontal and lateral views should be first made to determine the presence or absence of abnormal soft tissue shadows, the contour of the kidney outlines and the distribution of the gas-filled bowel loops. In cases where a catheter can be introduced into the abdominal opening of the urachus, visualization of the tract by means of 3 per cent sodium iodide solution may be used. Introduction of a catheter into the bladder through the urethra followed by the injection of contrast material into the bladder should also be attempted. This should be done with great care utilizing a sterile technique in order to minimize infection. This was attempted in

our case without success. Examination of the upper urinary tract to exclude abnormalities in this region by means of subcutaneous urography has been previously stressed. In older infants where retrograde pyelography and cystography may be utilized, direct examination of the bladder should be attempted.

The following case history is of interest because of the external abdominal mass which presented a difficult differential diagnostic problem, the roentgenographic procedures which were completed and the adequate recovery of the patient following surgery.

The patient, M. G., a female infant weighing 6 pounds and 10 ounces, was delivered on November 5, 1942. The cry was spontaneous and the color of the child was good. No abdominal rigidity or distention was noted nor



FIG. 1. The protruding cylindrical abdominal mass is shown above. The mucosa was at first thought to be small intestine in character. A wide diastasis of the rectus muscles could be palpated above the protrusion. For this reason, a persistent omphalomesenteric tract or a patent urachus associated with a congenital umbilical hernia was considered.

could any intra-abdominal masses be palpated. A well defined defect of the umbilicus with a protruding elongated mass covered with overhanging skin, the center of which contained mucosa resembling that of small intestine in character, was present. This cylindrical mass ex-



FIG. 2. A soft catheter has been introduced into the urachal opening and contrast material (approximately 10 cc.) has been injected.

tended out approximately 6.5 cm. from the anterior abdominal wall and was 3.2 cm. in diameter (Fig. 1). The examining surgical resident considered it to be a defect of the navel and a diagnosis of omphalocele was made. Roentgen examination was requested in order to determine whether or not air could be demonstrated within the mass in order to exclude a defect of the abdominal wall in which bowel was contained.

On November 12, 1942, during the examination of the patient, 1 cc. of clear yellow-tinged fluid was extruded from the center of the mass immediately after the patient had voided normally. Patency of the urachus was suggested by the type of fluid.

An attempt made to introduce a catheter into the urethra on November 18 was not successful. However, diodrast was injected by means of the catheter through the opening of

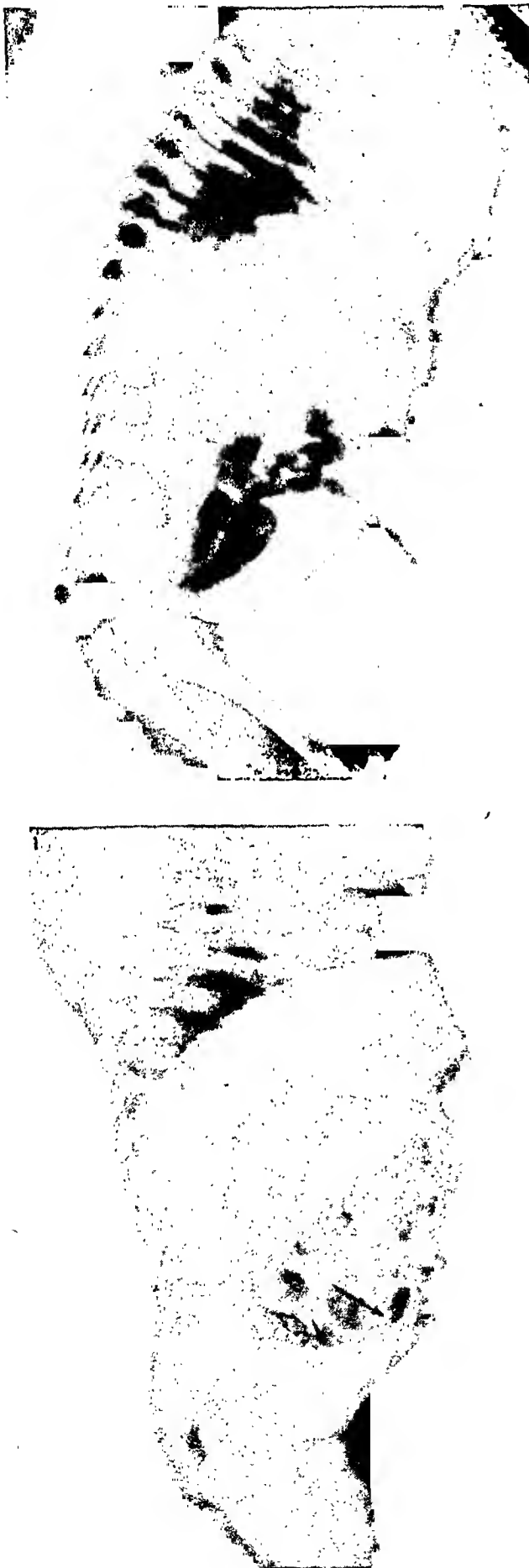


FIG. 3. Increased distention of the bladder by the dye is noted.

the abdominal mass and visualization of the bladder and the urachal stalk was demonstrated at this time (Fig. 2 and 3).

On November 27, examinations of the gastrointestinal tract were completed in order to exclude defects of the gastrointestinal tract. An upper respiratory infection at this time made it



Fig. 5. Contraction of the bladder following urination and the passage of the contrast material through the patent urachus are shown.

necessary to postpone the additional roentgen procedures. On December 7, subcutaneous urography was completed demonstrating normal pelvis and calyces in the upper urinary tract.

FIG. 4. The protruding mass in the umbilical region is demonstrated. Diodrast outlines the bladder and the urachal stalk. The contrast material (35 per cent diodrast in normal saline) is seen in the posterior scapular area. The frontal views demonstrated a normal upper urinary tract.



The ureters also appeared normal (Fig. 4 and 5).

In the interim, the protruding abdominal mass reduced itself markedly in size and the patient had continued to gain so that on January 1, 1943, the patient weighed approximately 8 pounds and 6 ounces.

On January 6, operation was performed by one of us (R. W. N.). A transverse elliptical incision was made about the umbilicus as in a typical Mayo umbilical hernia procedure. The

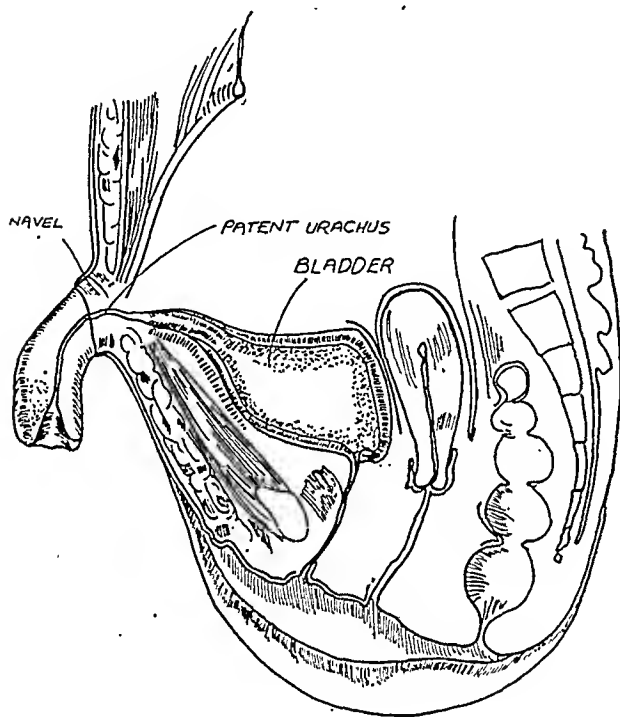


FIG. 6. Diagrammatic sagittal section through the lower abdomen demonstrating the relationship between the bladder, urachal stalk and the umbilical hernia.

anterior rectus sheath was widely exposed about the umbilicus and then opened transversely, exposing the peritoneal cavity. Exploration showed that the bladder connected almost directly with the umbilical opening. The round ligament of the liver was seen extending upward from the umbilicus and below two yellowish cords were seen and assumed to be obliterated hypogastric vessels. The narrowed urachal stalk and portion of the bladder attached to the umbilicus were excised and removed along with the umbilicus. The open bladder was closed with a double inverting running suture of

Lukens gut, and then allowed to retract to its normal position. The rectus sheaths and peritoneum were overlapped from above downwards with interrupted mattress sutures of chromic gut and the skin closed without drainage. The postoperative course was uneventful. The wound healed without any discharge and the child urinated normally. The patient was discharged from the hospital on January 18, 1943.

The patient has been seen on numerous occasions in the out-patient department and has continued to gain weight. No urinary difficulty has been experienced at the present time.

On October 5, 1943, an attempt was made to introduce a catheter into the urinary meatus in order to demonstrate the bladder but this could not be successfully completed.

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# DYSCHONDROPLASIA WITH HEMANGIOMATA (MAFFUCCI'S SYNDROME)

## CASE REPORT

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IN 1942, Carleton, Elkington, Greenfield and Robb-Smith<sup>1</sup> reported 2 cases of dyschondroplasia associated with multiple hemangiomas. They were able to collect 18 additional examples after a thorough search of the literature. In almost all of the total of 20 cases thus reported the deformities were quite severe, some requiring amputation of an extremity.

According to Carleton's group, this combination of an osseous and a vascular non-genital defect was first reported by Maffucci in 1881. Although the original report was not available to them, it had been quoted at length by Torri.<sup>2</sup> The typical case, as described by Carleton and her co-authors, is usually a male (14 of 20 cases), who is normal at birth. During the prepubertal years small nodules, 1 or 2 cm. in diameter, appear on the small bones of the hands or feet. Later other nodules are noted, some on the long bones. The distribution is unilateral or markedly asymmetrical. Dilated veins and soft, bluish tumors become apparent in a similar distribution on the extremities and on the trunk. Fractures may follow trivial injuries and union often delayed. Development of the two sides of the body is sometimes unequal and the distortion of the normal bone structure may result in secondary deformities such as pes planus, genu valgum and scoliosis. In some cases the alterations of the hands and feet are so grotesque that the extremity is unrecognizable. The disease is stationary after full growth has been reached, but most of the patients are short and have poorly developed musculature. Intelligence is average. Occasionally malignant changes in the bone lesions may occur.

The roentgenologic findings are quite striking. The small bones of the hands and feet (but not the carpus and tarsus) are the

seat of multiple small cystic areas (enchondromata), with irregular expansion of the cortex and widening of the shafts. The bones are thus quite irregular in outline. Similar areas may be seen in the long bones and occasionally in the ribs, scapulae and vertebrae. Microscopic examination indicates that the dyschondroplasia results from failure of absorption of the cartilaginous growth plate of the epiphysis. Osteochondromata may be present. Phleboliths can be seen in the hemangiomas.

The changes are undoubtedly congenital in origin, but there is no evidence that it is inherited. The association of multiple hemangiomas and dyschondroplasia is probably a coincidence. The syndrome belongs to the group of congenital mesodermic dysplasias.

The following case is an example of a milder form of this entity, and is reported because of the belief that such less pronounced cases are more common than would be supposed from the fact that only 20 instances have been reported to date.

## CASE REPORT

The patient, a twenty-seven year old soldier of Italian parentage, was admitted to the Station Hospital on December 28, 1942, complaining of a "lump on the left shoulder," which was painful and tender when he wore a pack.

No member of his immediate family had ever had any similar tumors. The mass on the left shoulder, in the region of the scapula had been present for at least ten years and had not changed in size. He had sustained "baseball" fractures of the second and third digits of the left hand some ten years before his admission to the hospital, and dated the deformity of these fingers from that accident. The soft tissue tumors to be described had been present "ever since he could remember."

The patient was 67 inches tall and weighed

FIG. 2. Left wrist. In the soft tissues on the dorso-medial aspect of the distal end of the ulna there is a rounded soft tissue mass, containing several small, well defined calcified shadows approximately 1 mm. in diameter (arrows). Similar shadows are seen in a soft tissue mass at the proximal end of the fifth metacarpal (arrows). These represent phleboliths in hemangiomata.

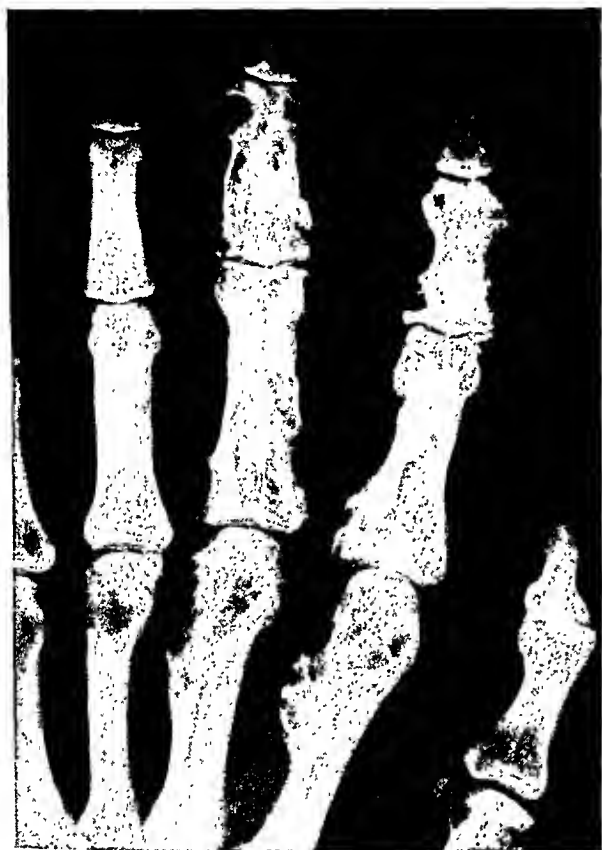


FIG. 1. Left hand. The second and third digits are the seat of numerous small cystic areas (enchondromata), which in some places cause expansion of the cortex. The shafts of the phalanges are irregularly widened. The trabeculae are coarsened and spicules of bone arise from the cortex and extend into the soft tissues. In the distal ends of the second and third metacarpals similar cystic areas are present, as well as projections of bone from the cortex which resemble small osteochondromata. The articular surfaces are not involved. (The right hand and wrist were normal.)



FIG. 2

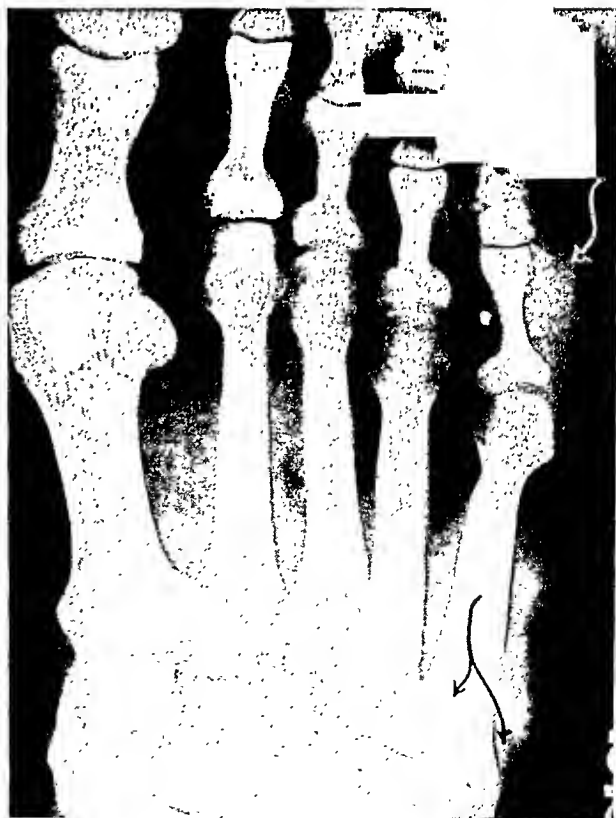


FIG. 3

FIG. 3. Left foot. In the soft tissues of the fifth toe (arrow) and of the lateral border of the foot (arrows) there are a number of small phleboliths. The soft tissue margin along the lateral border of the foot is wavy, due to the presence of a series of small hemangiomata. The bones are normal. (The right foot was normal.)



FIG. 4. Left ankle, lateral view. A cluster of about 30 sharply defined small (1 to 3 mm.) calcified shadows (arrow) are present in the soft tissues behind the talus. In the anteroposterior view this group of calcifications was seen to be lateral to the achilles tendon. A similar cluster of phleboliths is present below the calcaneocuboid articulation (arrow). These calcifications were at sites of the hemangiomas visible clinically. (The right ankle was normal.)

145 pounds. There was no asymmetry in development. Circumferential and linear measurements of the upper and lower extremities were equal in each case. The right side of the body was normal, both by physical and roentgenologic examination.

A number of tumors, some bony and some vascular, were present on the left side of the body. The bony tumors are described first. A low, rounded, hard, slightly tender tumor was attached to the spine of the left scapula. At the third left costochondral junction there was a hard, immovable tumor, about 3 cm. in diameter and not attached to the skin. The second and third digits of the left hand were grossly deformed and made irregular in outline by a series of bony hard, non-tender nodules. There were similar hard swellings on the dorsal surface of the left second and third metacarpals.

In addition to these bony tumors, soft tissue tumors were present over (1) the left third rib anteriorly (just lateral to the bony tumor), (2) on the dorsomedial surface of the distal end of the left ulna, (3) on the dorsum on the left hand, (4) just lateral to the left achilles tendon, (5) below the tip of the left lateral malleolus and (6) along the dorsolateral and plantar surfaces of the left foot. All of these soft tissue tumors were from 1 to 3 cm. in diameter, were attached to or within the skin, non-tender, slightly movable and in some instances could be made smaller by firm pressure. Those on the dorsum of the left hand appeared to be attached to the underlying tendons. Most of the tumors had a bluish tinge of varying degree.

The roentgenologic findings are illustrated in

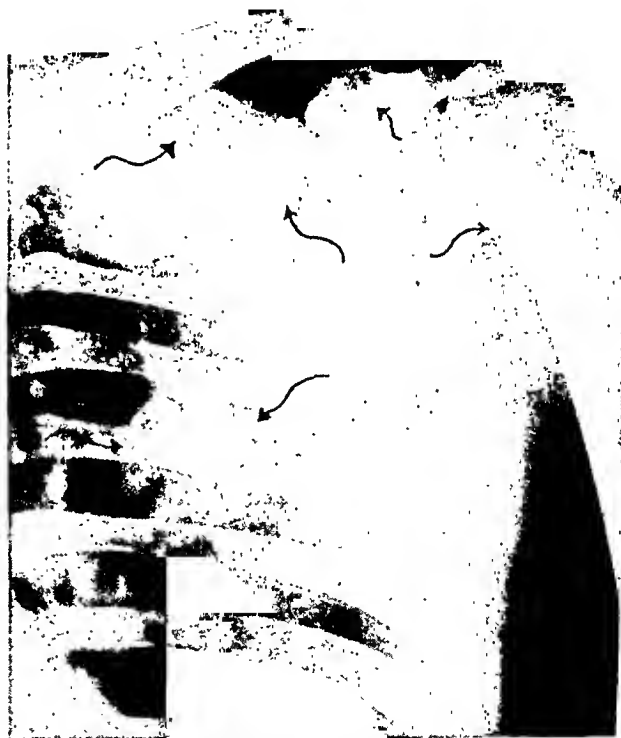


FIG. 5. Left shoulder and ribs. The anterior end of the third rib is expanded and a tumor containing irregularly distributed, stippled calcification is present (arrow). This tumor measured 3 cm. in diameter and represents a typical osteochondroma. In the middle of the spine of the scapula and on the coracoid process (arrows) there are similar small osteochondromata. There is also a small cystic area in the medial portion of the neck of the humerus (arrow). (The right shoulder girdle and the remainder of the thorax were normal, as were the vertebrae, pelvis and skull. There were a few phleboliths [not shown] in the soft tissues just above the lateral condyle of the left femur.)

Figures 1, 2, 3, 4 and 5 and are described in the legends. All positive findings were on the left side of the body. Roentgen diagnoses of (1) numerous phleboliths in multiple hemangiomata, (2) pronounced dyschondroplasia in the left hand and (3) osteochondromata of the third left rib and of the left scapula were made. The patient was returned to duty on a limited service status.

*Comment.* This case represents a mild degree of the syndrome, which according to Carleton *et al.*, was originally described by Maffucci. At the time this patient was seen and the diagnoses made, we were not aware

of the fact that this combination had been reported as a definite clinical entity. It is probable that, in a mild form, this combination is not an infrequent occurrence.

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# PRESENT VALUE OF ROENTGENOLOGY IN THE DIAGNOSIS OF APPENDICITIS\*

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**E**VEN though the roentgenologists of the world have been engaged in the study of the appendix for the last thirty-five years and although the majority have expressed their opinions either in articles or lectures, there is no doubt that recently considerable confusion has existed regarding the value of the roentgen examination in the diagnosis of appendicitis; not only between surgeons and clinicians, but also among roentgenologists themselves. Therefore, it seems advisable as well as necessary to discuss the problem in this Congress of Radiology, in order to know to what extent we, the American roentgenologists, are in agreement regarding the use of roentgenology as a diagnostic aid in these cases. Appendicitis continues to be excessively prevalent in all countries, and because of the diagnostic difficulties present in many cases plus the slight risk now involved in the surgical treatment, many patients are thus diagnosed who show no evidence of this disease at the time of surgical removal.

Of the three types of appendicitis, the acute, the chronic and the recurrent, the last two named are more frequently studied by the roentgen ray. Therefore, it is to these to which I shall refer in the course of this dissertation.

In sudden attacks of acute appendicitis the surgeon diagnoses it immediately by the patient's symptoms, without need or time for roentgen examination. It is therefore exceptional to study a case of acute appendicitis roentgenologically. In such instances, a simple examination of the abdominal cavity may be made or a roentgenoscopic study by means of an opaque enema. According to Case, the examination by opaque enema, using a dilute solution of umbrathor, must be performed with

great care and under the control of roentgenoscopy in order to avoid any excess pressure which would force the substance through a perforated appendix into the peritoneal cavity. According to the same author, the surgeon can obtain valuable information following this technique, especially in cases of non-rotation of the colon (mesentery commune) when a pain in the left iliac fossa coincides with an appendicular lesion.

## DIFFERENT PERIODS THROUGH WHICH ROENTGENOLOGY OF THE APPENDIX HAS PASSED

In my opinion, since 1909, when Bécclère succeeded in obtaining the first roentgenogram of the appendix, until today, roentgenology of the appendix has passed through four different periods.

*First Period.* During the first years investigators were concerned with (1) demonstrating that the appendix could be filled with an opaque substance and could therefore be seen by roentgenoscope or roentgenogram; (2) improving the technique, and (3) searching for roentgen signs in the morphology, the evacuation, the mobility of the appendix and the localization of the pain, which would make them suspect an inflammatory condition of the appendix. The efforts of Bécclère, Holzknecht, Grigorieff, Bennett, Desternes, Case, Jordan and Cohn deserve special mention. Their research demonstrated the variability of appendicular pain in different individuals, and at the same time the conclusion was reached that the appendix could be visualized in a certain proportion of cases varying from 33 to 70 per cent.

*Second Period.* In the second period, which was initiated by the European school,

\* Presented at the First Inter-American Congress of Radiology, Buenos Aires, October, 1943.

they began to look for demonstrative reflex signs of an inflamed appendix in the organs of the digestive system, apart from the appendix itself. Here we find the work of Aimé and Haym, Strom, Cambies, Beaumel, Jacquet and Gally, Laroche, Garcin, Pescatori, and others. This period could be called clinical-physiological, inasmuch as, following the clinical teachings and bearing in mind that the digestive organs form a harmonious composite and that a pathological condition of one part can cause disturbances in another some distance away, the function of the entire digestive tract is studied and thus the reflex gastrointestinal signs are of value in the diagnosis of appendicitis.

*Third Period.* Subsequently, due principally to the influence of the North American school, the importance of the distant reflex signs diminished. The direct symptoms roentgenologists observed in the appendix and the ileocecal region again became the sole supporters of the roentgen diagnosis.

*Present Period.* Finally, we are in a period of confusion in which some authors, such as Thomas Scholz, believe that the only sign of value in the roentgen examination is the localization of pain over the appendix. Others, following Carman's school at the Mayo Clinic, dispense with the roentgen examination in the study of chronic and recurrent appendicitis. And, although a divergence of opinion has arisen among roentgenologists, the skepticism is even greater among clinicians and especially among surgeons.

The different periods through which the use of the roentgen ray in the study of appendicitis has passed and the diversity of opinion among roentgenologists, clinicians and surgeons have two explanations, in my opinion.

First, the clinical evolution of recent years, and second, even after removal of the appendix and its histopathological study it is difficult to know exactly whether this was the exciting cause of the patient's trouble.

*The Clinical Evolution in Recent Years.*

The glorious clinical era was headed by the French school, reaching its peak at the beginning of the present century. For diagnostic purposes it was based exclusively on the association of a series of clinical symptoms, which singly were not of great value, but which considered as a whole afforded a very reliable diagnosis. Pathognomonic signs of determined entity were not dealt with, but symptoms common to different diseases, which group themselves in one form or another, constituted the different pathological entities.

The advent of the roentgen ray and laboratory tests promoted a fundamental change in clinical concepts. New examining procedures could not be overlooked because they furnished the doctor diagnostic findings which we may call pathognomonic, such as the presence of Koch bacilli in the sputum of tuberculous patients or a niche in roentgenograms of an ulcer. For this reason, the conclusion was reached that clinical diagnosis was of no real value unless, by some means, pathognomonic signs were found that would prove the existence of definite disease.

And as roentgenology has followed an evolution parallel to that of the clinical, roentgenologists now try to confirm their diagnosis with the pathognomonic sign, forgetting that an aggregate of symptoms is still of great value in diagnostic orientation.

#### DIFFICULTIES ENCOUNTERED IN ASCERTAINING WHEN AN APPENDECTOMY IS JUSTIFIED

The diversity of opinion with respect to the usefulness of the roentgen examination and the importance of roentgen signs corresponds with the uncertainty of the surgeons and clinicians in determining in which cases of chronic or recurrent inflammation it is necessary to remove the appendix.

This uncertainty is due to the fact that today it is impossible to know, even with microscopic study of the appendix, if the discomforts of the patient were produced



by a chronic or a recurrent appendicitis, because nearly all appendices present microscopic lesions due to inflammation. Therefore, from what we know at present, there is no roentgen sign that can be considered pathognomonic in appendicitis.

*Physiology of the Appendix.* Although the appendix has no well defined physiological function, being a part of the lymphatic system it plays a part in the physiology of defense, as a producer of white blood cells. The lymphocytes and non-granulated mononuclears formed by the appendix have important functions: they capture the solid particles they find and devour the bacteria in order to protect the body against infectious disease; they excrete an antitoxin and produce oxidases and other elements which aid the digestion of fats and albumins. The appendiceal fluid has diastatic properties (Rober and Josué); the appendix, like all lymphoid tissue, provides nuclear material for the various organs of the human body (Jolly and Saragea); and according to Portier's experience, the appendix of the rabbit regenerates itself, because there is hypertrophy of the lymphoid tissue of the cecum in the proximity of the resected appendix.

If the removal of the appendix does not affect the human organism, I find the explanation in the fact that the other abdominal lymphoid tissues perform its functions after the appendectomy.

As the appendix is a sac or tube that has no other opening except that which connects it with the cecum and as in this aperture there is a valve, or fold, of the mucosa (Gerlach, 1847), retention or impairment easily occurs in the entrance and exit of substances from the cecum. This anatomical characteristic that so easily provokes disturbances in the evacuation of the appendix, the fact that the appendix is the site of election in the intestine for the elimination of various microbes (Roger, Ribadeau-Dumas and Harvier, Nordwinkin), and the richness of the cecal microbic flora, are undoubtedly the reasons why this lymphoid

apparatus, similar to others of the abdominal cavity, is affected so much more frequently.

*Healthy and Diseased Appendices.* According to Vaughan, only from 10 to 25 per cent of adults show no appendiceal lesions. Méndez Lemaitre, of Bogotá, states that of 18 patients on whom a prophylactic appendectomy was performed during surgery for another abdominal lesion and in whom there had been no previous clinical history of appendicitis, only in 2 was the appendix histologically normal.

Scholz found in 46 autopsies only 2 appendices that could be considered normal, although there had been no confirmed signs of appendicitis during the life of any of the 46 patients.

My good friend and colleague, Dr. Howard Hartman of the Mayo Clinic, tells me he does not remember having seen even one report from the pathologists of that institution in which there was not mentioned some abnormality of the appendix.

Inasmuch as the majority of appendices present histological proof of inflammation—both those considered clinically healthy as well as those that have been removed because they were thought to be diseased—the logical conclusion is that the only way of knowing whether or not the appendix was the cause of the patient's discomfort lies in the disappearance of the clinical symptoms after the appendectomy.

The same thing occurs with the appendix as with the palatal tonsils, which are also lymphoid defense tissue. For one reason or another, acute or subacute inflammatory conditions occur, which pass, leaving at times macroscopic traces of the inflammation and at others microscopic.

One of my case histories illustrates this point: The patient, N. N., was examined after an attack of subacute appendicitis. As I found the appendix erect, very painful, about the size of the little finger and very long, I was not in doubt as to its pathological condition. The patient was not operated on and a few days later the clinical symp-

toms disappeared. Two months later I made new roentgenograms. In this second examination I found the appendix of normal size, perfectly movable and without pain on palpation. I have cited this case because it is unusual not to operate after a clinical and roentgen diagnosis of appendicitis, and therefore one rarely has the opportunity of performing two roentgen examinations at different periods.

Thus it is clear that no definite criterion can exist as to when surgical intervention is justified in cases of chronic or recurrent appendicitis, since histopathology justifies almost all appendectomies.

#### IMPORTANCE OF ROENTGEN STUDIES BEFORE APPENDECTOMY

As the surgical removal of the appendix causes no damage to the patient, since its function of defense is carried on by other lymphoid tissue in the abdomen and since the postoperative cases of adhesions or other sequelae are rare, we should reach the conclusion that in all cases diagnosed as appendicitis an appendectomy is justified, and also accept the prophylactic appendectomies performed to prevent acute attacks.

But, unfortunately, many post-appendectomy patients continue to have discomforts similar to those suffered previously.

Connell and Gibson say that in 40 per cent of 638 patients there was no improvement after operation. Coffey found no improvement in 70 per cent. Of 509 appendectomies in the Presbyterian Hospital in New York in 1922 there was no improvement in 24 per cent. These patients were then studied clinically and roentgenologically, the conclusion being reached that in only 8 there was no explanation of the symptoms, since in 17 there was some digestive lesion, 21 were suffering from neurosis to which the symptoms were attributed. Since 1923 patients have been examined by a psychiatrist before making a diagnosis of appendicitis, and from 1923 to 1925 the percentage with no improvement dropped to 14 per cent and

the number of operations was reduced from 73 to 48 per year.

If more attention were paid to the careful study of the patients to be operated upon, appendectomies would decrease in number instead of increasing as is happening today, especially in private clinics. In the city of Bogotá in 1933 appendectomies represented 8.6 per cent of the total surgery performed in charity hospitals and 22 per cent of that performed on private patients. From 1936 to 1942, of 7,250 surgical interventions on private patients, 1,925 were appendectomies, that is to say 26 per cent of the total surgery.

In my statistics from the Marly Clinic I find that of 21,000 patients examined roentgenologically there were 1,738 diagnoses of appendicitis. And 793 patients, or 45.63 per cent, demonstrated some other digestive lesion along with the appendicitis.

Complementing the aforementioned and bearing in mind the scientific value of the opinions of my respected friend, Dr. Lay Martin, I deem it of great interest to quote a few paragraphs of the interesting letter he wrote to me concerning our present theme:

Frequently appendices which are removed show evidence of inflammation. Many times it is very difficult to tell whether it is a long standing, subacute condition, or whether it is the result of a subsiding inflammatory disease. Certainly there is evidence that the appendix is diseased. However, that is not proof that the diseased organ was responsible for the symptoms of the patient. The only real proof of this is clear cut evidence that the symptoms of the patient have disappeared following the appendectomy.

I have no reason to feel that the removal of a normal appendix is detrimental to the patient, but when I say this, I wish to clarify my position as follows:

Many times doctors incriminate the appendix as responsible for the patient's symptoms when there is very little or no evidence that the organ is diseased. The removal of such an organ in an attempt to cure the patient is usually a most unsatisfactory procedure. Not only will the patient not be cured, he may be made worse by

the development of subsequent adhesions. If his symptoms were neurogenic to begin with, they may disappear for a time following the removal of a normal organ but they are very apt to return when the patient again finds himself in positions which are incompatible with his psyche. In other words, I believe that it is perfectly proper to operate upon a patient for the removal of a normal appendix knowing that it is a normal appendix that one is going after and that the removal of the normal appendix is a prophylactic measure designed to prevent a potential rupture some time later in life when the patient may be far removed from medical centers. The thing that I decry is the removal of an appendix on the supposition that the appendix is the basis for the patient's symptoms without careful study being given both clinically and roentgenologically under the direction of an experienced clinician and radiologist.

Roentgenology, as an aid to the clinical examination, is in my opinion the most useful and beneficial procedure to be found for the study of suspected cases of chronic or recurrent appendicitis, provided a complete examination of the digestive tract is made following a suitable technique.

In this respect Case has said: "The X ray investigation of any part of the alimentary tract must be incomplete unless it includes a careful study of the entire digestive system. The technic of the examination of the appendix is only a part of the routine which should be pursued in every gastrointestinal case, and unless circumstances prevent, no opinion is expressed on any single part of the digestive tract until the entire examination has been completed."

*Technique.* The technique I employ is as follows: The evening before the examination I instruct the patient to take one or two doses of tetraiodophenolphthalein, according to his weight, and the following day he comes without breakfast for the first roentgenograms of the hepatocholecystic region. If in these plates I observe any abnormal shadow in the renal-urethral area, I then take a simple roentgenogram of the urinary tract.

Immediately thereafter, I observe the patient roentgenoscopically in order to

study the thorax, esophagus, stomach and duodenum. If I find any thoracic abnormality, I take roentgenograms of the thorax when the routine gastroduodenal views are taken.

Six hours later I carry out another roentgenoscopic and roentgenographic examination, being careful to study the patient minutely in anteroposterior, semi-lateral and lateral positions. At this time I take another film of the cholecystic region.

Twenty-four hours after the first dose of barium and twelve hours before the ingestion of a second dose, I perform new roentgenoscopic and roentgenographic examinations of the cecal region. I sometimes re-study the patient the following day or complete the examination with the help of an opaque enema.

*Importance of the Study of the Gallbladder.* The ingestion of the tetraiodophenolphthalein the evening before the examination fulfills three purposes: first, to study the gallbladder, since I have found lesions in this organ in connection with appendicitis in 17.60 per cent of cases studied; second, to be able to have a well defined image of the liver on the roentgenograms, since its shadow can be clearly seen when the gallbladder has been filled with tetraiodophenolphthalein, and third, to take advantage of the laxative properties of the phenolphthalein forming part of the iodine compound, which helps to increase the visibility of the appendix in the subsequent examinations.

The different procedures, advocated by Czepa, Cambies, Armari, Gallard, Monés, Orlansky, and others, all have the same objective of emptying the intestine, especially with laxatives, since experiments show that in this way the visibility of the appendix is increased. Chizzola demonstrates an increase of 40.8 to 58.6 per cent in the visibility of the appendix if the intestine is previously emptied, especially when magnesium sulfate is used.

With respect to the laxative and purgative effects of tetraiodophenolphthalein, I have obtained the following figures on 2,000 patients who have taken it:

	Cases	Per Cent
One evacuation before taking barium..	793	39.65
Two evacuations before taking barium.	253	12.65
Three evacuations before taking barium	179	8.95
Four to five evacuations before taking barium.....	160	8.00
Six to nine evacuations before taking barium.....	59	2.95
Ten or more evacuations before taking barium.....	22	1.10
No evacuations before taking barium..	534	26.70

Nor can it be said that the ingestion of tetraiodophenolphthalein causes much discomfort to the patient, because only 29.30 per cent were nauseated and 5.83 per cent had vomiting. The rest, or 64.87 per cent, experienced nothing unusual after the ingestion.

*Importance of the Gastroduodenal Examination.* I consider the study of the stomach and duodenum necessary because many patients attacked by appendicitis also present gastroduodenal lesions. In my statistics I find that in 1,738 patients with appendicitis, 157 also had gastroduodenal lesions.

*Importance of the Thoracic Examination.* Although clinically unsuspected thoracic lesions are rare, it is justifiable to prolong the roentgenoscopic examination a few more seconds in order to eliminate them, since in 1,738 patients with appendicitis I found 60, or 3.44 per cent, who also had cardiopulmonary lesions.

*Importance of Repeated Examinations of the Cecum.* I have insisted on the necessity of repeated roentgenoscopic and roentgenographic examinations in different positions six, twelve and twenty-four hours after the ingestion of barium, because at the same time that the colon is being carefully studied the appendix is visualized with much greater frequency. The lateral examinations are indispensable for they are the only means of obtaining a view of retrocecal appendices, so frequent in ptosis of the cecum.

*Value of the Roentgen Examination.*

The roentgen examination is useful for three reasons:

1. *For the Exclusion or Confirmation of Lesions in other Organs.* By performing a roentgen examination in the manner described, we can dismiss or confirm the presence of lesions in other organs, which may be the cause of the symptoms or which may coexist with an appendicitis.

Even if we were to accept, like Carman, that "when X rays exclude the stomach and duodenal lesions they have done a great service and therefore, no more can be asked," that service would be very great, since in 45.63 per cent of the patients I have found lesions in other organs coinciding with appendicitis.

The following are the statistics on 21,000 patients whom I have examined roentgenologically in my department in the Marly Clinic:

In 1,738, or 8.27 per cent of those examined, a diagnosis of chronic or recurrent appendicitis was made. Of the 1,738 cases, 880 were women, 858 were men. Adhesions were found in 100, or 5.75 per cent.

With respect to age, in 306 cases the average was thirty years, because in a grouping made in a polygon of frequencies, the arithmetical mean and the median coincide at this figure. It is interesting to note a higher frequency at forty years and at twenty-six years, as well as the fact that the frequencies occur in pairs, a lesser always followed by a greater pair.

Two hundred and fifty-eight cases of spastic colitis were diagnosed, or 14.84 per cent, many of them being an appendicular reflex. Besides spastic colitis, 793 cases were found in which the appendicitis coexisted with another disease, as follows:\*

	Cases	Per Cent
Appendicitis associated with:		
amebic colitis.....	183	10.52
gastroduodenal ulcers.....	67	3.85
duodenitis and periduodenitis.....	90	5.16
cholecystitis with visible calculi.....	62	3.56
cholecystitis without visible calculi..	103	5.93
cholecystic atony.....	29	1.66

\* The total number of appendicitis cases associated with other lesions is greater than 793, because several of the patients had a history of two or more roentgen diagnoses.

poor cholecystic function.....	112	6.45
gastrointestinal ptosis.....	171	9.83
cecal-colonic ptosis.....	150	8.63
cardio-aortic dilatations.....	44	2.52
pulmonary lesions.....	16	6.92
utero-adnexal lesions.....	38	2.18
others.....	249	14.32

The diagnostic value of elimination is so important that those clinicians or roentgenologists who do not perform roentgen examinations to confirm or invalidate a diagnosis of appendicitis, are supporting their other clinical diagnoses by examinations of elimination with roentgenology. My esteemed colleague, Dr. Howard Hartman of the Mayo Clinic, has been kind enough to give me his opinion as to why that institution has laid aside roentgen examinations made especially to study the appendix. He states:

We never x-ray the patient to make a diagnosis of acute or chronic appendicitis. Few people of adult years avoid some degree of inflammation in the appendix and practically every appendix that is removed routinely at operation is reported by the pathologist to be chronic catarrhal appendicitis. At times this type of appendix is capable of developing acute symptoms, and we rely upon the symptomatology of acute attack whether actually visualized by us or obtained through history to warrant the removal of the appendix. With such an attack in the history, and soreness and tenderness on pressure over the appendix, if it is sufficiently severe, we think it justifies the removal of the appendix.

There is apparently a discrepancy between Dr. Hartman's opinion and that which I was defending regarding the utility of the complete roentgen study of the digestive system in cases of appendicitis. If we bear in mind that at the Mayo Clinic routine examinations are made of the thorax, the urinary system, the spinal column, and of the digestive system when lesions of that apparatus are suspected, it is understood, although not explicitly stated by Dr. Hartman, that the clinical diagnosis was carried out without roentgen study of the cecal-appendicular region, but the other diseases that could be confused with appendicitis or

coexist with it are naturally eliminated first, through the clinical examination, the laboratory and especially by roentgen examination.

2. *For the Direct Cecal-Appendicular Signs.* In the second place it must be remembered that the clinical examination gives no information regarding the location, morphology, filling, evacuation, mobility, permanent kinks or appendicular adhesions. And these details, which are so important, not only for the diagnosis of an inflammatory condition, but also for the knowledge obtained from them regarding the anatomical condition of the appendix which assists the surgeon in adopting an appropriate surgical technique in each case, can easily be procured with great precision by means of roentgen examination.

I want to quote part of a letter in which my esteemed friend, Dr. James T. Case, deals with this debatable question of the appendix. He enumerates all the direct roentgen signs looked for in the cecal-appendicular region, and thus I will be able to comment on them and discuss the value of each.

Dr. Case states:

If the appendix fills and empties coincidentally with the filling and emptying of the cecum, and if it is freely movable and does not very accurately coincide with a point of tenderness on pressure, I consider the appendix normal, at least at the time of the examination. Of course, one may have an appendix which on a previous occasion was acutely involved in suppuration but from which the patient may have recovered, and at the time of our examination the appendix may behave normally to the X-ray examination. In such a case I merely report that at the time of my examination the appendix is normal if the conditions above enumerated are found to be present.

On the other hand, if in spite of very careful examination we have failed to visualize the appendix (and it has not been removed) then we have excellent reason for assuming that it is pathological and its lumen obstructed by kinking or by obliteration. I have been able to state, for instance, that an appendix has been obliterated for its entire extent except for the proximal

1.0 cm. I have been able to show up a residual stump of an appendix after appendectomy. A fixed position of the appendix in all examinations in spite of various maneuvers suggests adhesions. In such a case one may rather safely state that adhesions are present. A retrocecal appendix is nearly invariably buried in congenital adhesions, and knowledge of this position will permit the surgeon to favorably modify his operative approach in contrast to his usual incision.

A kinked or sharply angulated appendix, appendical stasis for several days beyond the clearance of barium from the rest of the colon, or the presence of fecaliths in the appendix are all signs of appendical pathology. Appendical stasis is a menace just in the degree that the appendix retains its contents beyond the second or third day. I have seen appendical concretions of barium as long as thirty-three days after the barium meal.

*Visibility of the Appendix.* Let us discuss first whether a healthy appendix that has no kinks, adhesions or obstruction of the lumen is always visible in a roentgen examination.

I am convinced that the lack of visibility after a roentgen examination that is well done almost always implies the existence of a pathologic condition.

The advantage of making repeated examinations to increase the visibility of the appendix is well illustrated by the experience of Perotti and Codeca; they studied 100 normal children in several roentgen examinations. In the first they saw 61 appendices; in the second 23 more; in the third 13; and in the fourth they saw the last three. That is to say, they succeeded in visualizing all the appendices in four examinations.

In my statistics I find 226 patients in whom the appendix was not seen, from a total of 1,000 cases diagnosed as appendicitis. In other words, 22.6 per cent were not seen.

Walton and Weinstein did not see the appendix in 18 out of 152 cases diagnosed as appendicitis, which is 11.8 per cent.

The inability to visualize the appendix because of complete obstruction of the

lumen represents, according to Kelly and Hourdon, 5 per cent of the appendices removed, which is in accordance with the percentage obtained by Mallory in 4,000 autopsies.

The following authors cite statistics regarding the visibility of the appendix:

Ström.....	70 to 80%
Wood.....	93%
Schnack.....	75%
Moore and Merritt.....	80%

All the data given indicate that the appendix should normally fill with the barium and that the lack of visibility after careful roentgen examinations almost always indicates that the lumen is obliterated as a result of an inflammatory reaction.

*Kinks and Fixity of the Appendix.* When in repeated roentgen examinations we find the appendix markedly kinked or fixed, we may be sure that a pathological condition exists and suspect the presence of adhesions that would cause the kinking or fix the appendix in a definite position.

On this point there is no great difference of opinion among the investigators. To Walton and Weinstein a persistent angulation is a direct sign of an inflammatory condition. To Deaver and Ravdin the fixity or abnormal angulation indicate adhesions.

But it must be borne in mind, as Orley says, that fixity is of importance only when it is associated with functional disturbances, especially with pain. And it must be remembered, according to Scholz, that in many instances adhesions or kinks are erroneously diagnosed by examinations technically badly executed or by erroneous interpretation of the roentgenograms.

*Evacuation of the Appendix.* The appendix fills at the same time as the cecum and should empty in the same manner, due to the peristaltic movements noted by Cohn in 1911 and later corroborated by White. The segmented image that the appendix sometimes presents is caused by these peristaltic movements, and today there is no doubt as to its normality. On the other hand, the retention of barium in the in-



terior of the appendix when the cecum has already emptied has been considered pathological.

Although Assmann and Merlo Gómez feel that delay in evacuation may exist in normal cases, Fedder, Chizzola, George and Gerber, Sahyoun and Oppenheimer think that it is always pathological. To some, pathology begins when the appendix does not empty at the same time as the cecum, while to others it occurs when there is a delay of two or three days. Lay Martin feels that a retention of more than ninety-six hours generally indicates that the appendix has lost its contractile powers as a result of previous attacks of appendicitis.

To me, Case strikes a happy medium when he says that appendiceal stasis is a menace if the appendix retains its contents later than the second or third day. And it is clear that an appendix that retains food in its interior for many days indicates, as Vaughan says, poor drainage, and it is therefore a site for future inflammation. Retentive appendices are pathological or constitute a latent danger to the patient.

*Calculi.* The concretions found in the interior of the appendix may be transparent or opaque to the roentgen ray, but the first are doubtless more frequent. Such concretions or calculi are foreign bodies located in the interior of the appendix and therefore contribute by obliteration to the provocation of acute or subacute attacks. To Rolleston, Held, and Larimore, these concretions are proof of recent or old appendicular inflammation. Undoubtedly, the calculi are a contributing factor to inflammation, although it cannot be stated they are the cause, according to Vaughan. This latter author feels that the mucus secreted in the first inflammatory period combines with masses of bacteria and these form calculi which provoke the subsequent attacks.

Thus, the presence of calculi in the appendix is abnormal, because they are an important factor in future appendicitis attacks and because they often indicate that

there has been a previous inflammation of the appendix.

*Erect Appendix.* To the direct signs pointed out, I wish to add one that in my opinion is of great value. I refer to the finding of an appendix which during roentgenoscopy gives the sensation of "erection," with increase in thickness and disappearance or diminution of the curves that normally appear.

3. *For Reflex Signs.* The third and last point regarding the usefulness of the roentgen examination is based on the value of the reflex signs in the diagnosis of chronic and recurrent appendicitis.

The appendix, when diseased, is the starting point for reflexes which are interpreted as signs of vagotonia (Butmann, Enriquez and Rouvière).

*Pain.* The first of these reflex signs, and to me the most important of all, is pain. Among roentgenologists there is no difference of opinion about its indisputable diagnostic value. All agree that with roentgen examination the exact locality of the pain can be found over the appendix and the other painful sites that are clinically so confusing may be discarded.

Carman has said: "Without pain, the other signs cease to be convincing," and White adds: "It is very seldom that a patient needs an operation if there is no pain when the appendix is moved on palpating it." But others, such as Fedder, say with all fairness: "Pain has diagnostic value associated with other signs, because as Walton and Weinstein have noted, when the cecum is full it normally hurts to palpate it, because of the increase in intra-colonic pressure." And according to Sahyoun and Oppenheimer, the cecum is tender in 10 per cent of normal individuals.

On looking for pain it is important to make sure that a change in the position of the appendix brings about a change in position of the pain, the previous site ceasing to be sensitive.

Therefore, I consider appendicular pain properly observed during roentgenoscopy



as a symptom of great diagnostic value, but we cannot accept it as definite proof if it is not associated with other roentgen signs.

*Pylorospasm.* Pylorospasm, found so often in chronic appendicitis, is confirmed by a six hour gastric retention and tenderness on palpation of the pyloric region. I therefore call it painful pylorospasm. Many authors have mentioned it, such as Oppenheimer, Walton and Weinstein, Merlo Gómez, Feldman, and others.

The epigastric pains, the nausea and vomiting observed so frequently in chronic appendicitis are explained by these spasms.

Also, it is wise to remember that at times juxtapyloric and duodenal spastic deformities appear, which lead to errors in diagnosis. It is also possible to commit this error clinically, since Poenaru and Caplesco found 14 per cent of 2,000 appendectomies with reflex symptoms that simulated gastric ulcers.

*Aerogastria.* Besides the pylorospasm resulting from a six hour retention and as a direct consequence of it, I have been able to prove on many occasions an increase in the size of the air chamber, accompanied by a slight ascension of the left side of the diaphragm.

The oppression and the palpitations that trouble some cases, especially after meals, almost always coincide with aerogastria.

*Increase in Size and Density of the Liver.* The close relation that exists between chronic appendicitis and hepatic function is clinically recognized by the symptoms of slight hepatic insufficiency and by the slight increase in the percussion area of the liver. These reasons explain why I consider as roentgen reflex signs of chronic appendicitis an increase in the density and a slight increase in the size of the hepatic shadow.

*Ileal Retention. Constipation.* After pain, ileal retention is the most noted roentgen sign of appendicitis. Among numerous authors who have noted it we may cite Jacquet and Gally, Laroche, Guy, Brodin and Ronneaux, Colaneri, Garcin, Smyrniotis,

Chizzola, Estor, Orlansky, and others.

Ileal retention is often accompanied by cecal stasis, and it is frequently the case that the cecum remains injected after the colon has emptied, as pointed out by Fedder, and Walton and Weinstein.

Ileal retention and stasis are the roentgenological proof of constipation, which clinically accompanies nearly all cases of appendicitis.

Ileal retention has no organic cause. It is explained by atony of the last loops of the small intestine, or by spasm of the cecal sphincter (Köhler), or by spasms of the valve of Bauhin, but the first hypothesis is more generally accepted. It is felt that one is dealing with a constipation of the small intestine similar to the cecal constipation which it accompanies.

Although gastric retention and ileal retention have the same value as appendiceal reflex signs, only White and a few other roentgenologists attach importance to the first. This is due to the fact that there are mistaken for ileal retention many cases in which retention has been the cause of finding the barium meal in the final part of the small intestine much later than it should be.

*Ileocecal Spasms.* As is natural, spastic deformities occur in the end of the small intestine and in the cecum, for these are the sites closest to the implantation of the appendix.

The ileal spasms are difficult to evaluate roentgenologically and may be taken for the anatomical lesions of a terminal ileitis. Spasms of the ileum have been demonstrated by Etienne and Piccarda, Jacquet and Gally, Pescatori, and others.

The spasmodic cecal deformities are common, but of variable aspect. They may be deformities from excess normal cecal contractions; or deformities that simulate adhesions; or spasmodic contractions of the external cecal wall with rigidity of the wall at the appendicular insertion, similar to that produced in the stomach by an ulcer of the lesser curvature; or diminution in the thickness of the inferior half of the cecum,

which gives this part an infundibular appearance; or, finally, a condition of atony, which has been mentioned by Walton and Weinstein.

But we must bear in mind that in spastic colitis there may be deformities of the cecum and of the ascending colon similar to those found in appendicitis. Thus, it is also common to observe signs of spastic colitis as a reflex of an appendicitis (Jacquet and Gally, and Huet). In some cases I have been able to verify the disappearance of the roentgen signs of spastic colitis after removal of the appendix.

The presence of signs of spastic colitis is frequent, for in my statistics I find 258 cases which coexisted with an appendicitis.

According to Balli, these images can be explained if it is remembered that the segments of the colon react by spasmodic contractions in certain areas in response to visceral-motor, visceral-sensory and visceral-secretory stimuli, especially in those sites which correspond to the different cecal-colonic sphincters. Ienino, Perotti, Guidotti, Busi and Hirsh have also found permanent contractions in appendicitis in several of these sphincters.

The reflex signs I have just pointed out, including pain, agree with the various clinical symptoms of chronic appendicitis, and in my opinion are the only ones that plainly show the existence of an inflammatory condition of the appendix. The finding of an appendix macroscopically or microscopically diseased in the course of a laparotomy, without the patient suffering discomfort from it at the time of removal, only demonstrates that that patient—as the majority of adults—had suffered a previous attack.

The proof that several of these reflex signs, even discounting pain, can lead us to make a diagnosis of chronic appendicitis is found in one of the observations made in my doctorate thesis. There had been no pain on palpation, the diagnosis was made by the other reflex signs, the macroscopic and microscopic studies of the appendix revealed clear signs of inflammation, and the

digestive disturbances of the patient disappeared after the appendectomy.

### CONCLUSIONS

Summing up the foregoing considerations, I believe that in the present state of our knowledge we should accept as necessary and advantageous the complete roentgen study of the digestive tract when a chronic or recurrent appendicitis is suspected clinically. There are three reasons why this investigation should be carried out:

1. Because lesions of organs other than the appendix are confirmed or ruled out.
2. Because the direct signs found in the appendicular region supply data about the morphology, filling, evacuation, location and the presence of kinks or adhesions of the appendix, which cannot be obtained from the clinical symptoms alone.
3. Because when a chronic or recurrent appendicitis is suspected, the roentgen reflex signs, such as pain, pylorospasm, aerogastria, gastric retention, ileal retention, spastic cecal-colonic deformities, and so forth, show, in accordance with the clinical symptoms, that the process of appendicitis is active.

### SUMMARY

In view of the diversity of opinion prevailing today among clinicians, surgeons, and even roentgenologists as to the value of the roentgen examination in a suspected case of chronic or recurrent appendicitis, I have reviewed the various stages through which the roentgen diagnosis of appendicitis has evolved. I have reached the conclusion that this diversity of opinion is due to the change in clinical concepts during the last few years, and also to the lack of definite evidence to demonstrate that the removed appendix was, after all, the cause of the symptoms.

Nearly every adult has suffered at some time from an inflammation of the appendix. This explains why most appendices show signs of inflammation when microscopically

studied, even those that were considered more or less normal at the time of operation.

There is only one way of proving that the symptoms complained of by the patient were due to appendicitis, and that is their complete disappearance after appendectomy.

Because of our present knowledge, there can be no definite pathognomonic symptoms of chronic or recurrent appendicitis, therefore a thorough roentgenologic investigation of the digestive tract is not only useful but necessary for accurate diagnosis, for the following reasons:

1. It rules out or confirms the presence of disease in organs other than the appendix. (In 1,738 roentgen diagnoses of appendicitis, from a total of 21,000 patients examined, I found 45.64 per cent in which appendicitis was associated with some other disease.)

2. The direct roentgen signs found over the appendix and cecum give data concerning the shape, filling, evacuation, location, and kinks or adhesions of the appendix, which cannot be obtained through a clinical examination alone.

3. When a chronic or recurrent appendicitis is suspected, the indirect roentgen signs, such as pain on palpation, pylorospasms, aerogastria, ileal stasis, spastic deformities of the cecal-colonic region, and so forth, show, in accordance with the clinical symptoms, that the process of appendicitis is active.

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# ROENTGEN DIAGNOSIS OF INCIPIENT CANCER OF THE RECTUM

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## I. METHOD

CANCER of the rectum is not often discovered in incipient stages because it rarely causes clinical signs and symptoms until it has grown fairly large. Hence every method available should be used without prejudice in making an early diagnosis. The results of roentgen examinations have not been satisfactory. Controlled distribution of the opaque medium, on which the demonstration of gastrointestinal lesions depends in a large measure, is difficult to obtain in the rectum. Compression and palpation can rarely be applied effectively in this region, and the filling can be controlled only by regulating the inflow of the opaque fluid. This is not easy to achieve with the conventional enema technique. With the wide tubes generally used, the filling is often so massive as to obscure small lesions, or too scanty, after evacuation, to disclose sufficient detail.<sup>4</sup> Reflux into the ileum may overshadow the proctosigmoidal junction, in which at least 70 per cent of all benign and malignant lesions of this part of the colon are located; and the distress usually caused by rigid tubes, especially the self-retaining types, may set up motor irritation which interferes with the examination. These difficulties can be overcome by means of a few simple technical modifications which, used routinely since 1937,<sup>4</sup> seem to add to the value of roentgen examinations in the diagnosis of disease of the rectum and sigmoid.

*Preparation.* Soap-suds enemas and drastic cathartics, which may cause motor irritation,<sup>5</sup> should not be used. The night before the examination the patient has a light meal. Two hours later a saline enema is given. The next morning breakfast is omitted, and a second saline enema is administered two hours previous to the examina-

tion. This two hour interval is necessary lest retained parts of the enema simulate pathologic fluid levels or dilute the opaque medium. In the presence of tenesmus, discharge, and similar signs or irritation, one may use tea, a tannic acid solution, or a chamomile infusion instead of saline ene-



FIG. 1. Pressure defect caused by a distended urinary bladder. After catheterization, the rectum and sigmoid showed normal roentgen appearances.

mas, and atropine medication may be indicated. Painful lesions around the anus, e.g., fissures, inflamed hemorrhoids, and eczema, require the application of an ointment or/and suppositories containing a local anesthetic about one-half hour before

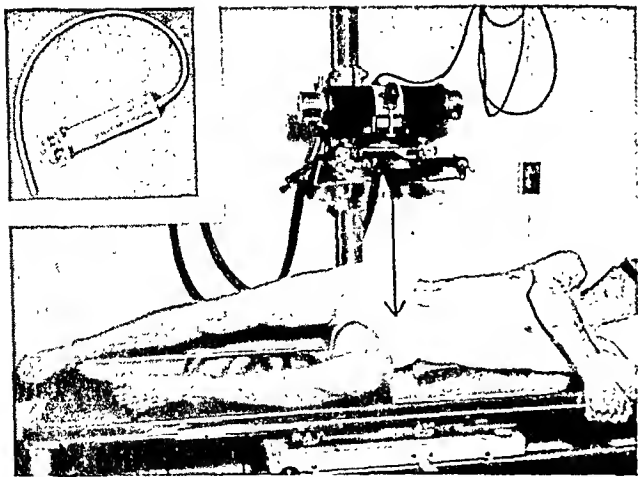


FIG. 2. Roentgenographic position for the oblique view of the rectum (see text). Insert: syringe and catheter used for roentgen examination of the rectum.

the examination is made. The bladder should be emptied, if necessary by means of a catheter, since a distended bladder may cause pressure defects in the rectum easily mistaken for tumor (Fig. 1).

*Roentgenoscopy.* A flexible urethral catheter is inserted into the rectum. The opaque medium is injected through the catheter with a 20 cc. syringe under roentgenoscopic observation while the cath-

eter is gently withdrawn towards, but not beyond, the internal sphincter. According to the degree of filling required in each case, opaque medium may either be added or withdrawn with the syringe. Spot roentgenograms may be made in various positions. Once the rectum and sigmoid are studied, the examination is completed by filling the whole colon. The catheter is left in place and is connected with an enema device. With some practice it is possible to regulate the flow of the opaque medium from the enema device so accurately as to make the use of a syringe unnecessary; but by adopting the syringe method first, the examiner will make himself more familiar with the technique. In most cases, 20 to 60 cc. of opaque medium are needed for the rectum and sigmoid, and 1 to 1½ pints for the entire colon. Air may be insufflated if necessary.

*Roentgenograms.* In addition to spot films, roentgenograms may be made in various projections according to the preferences of the examiner. The following positions are useful: (1) The patient is supine; the tube points downward with a caudal tilt

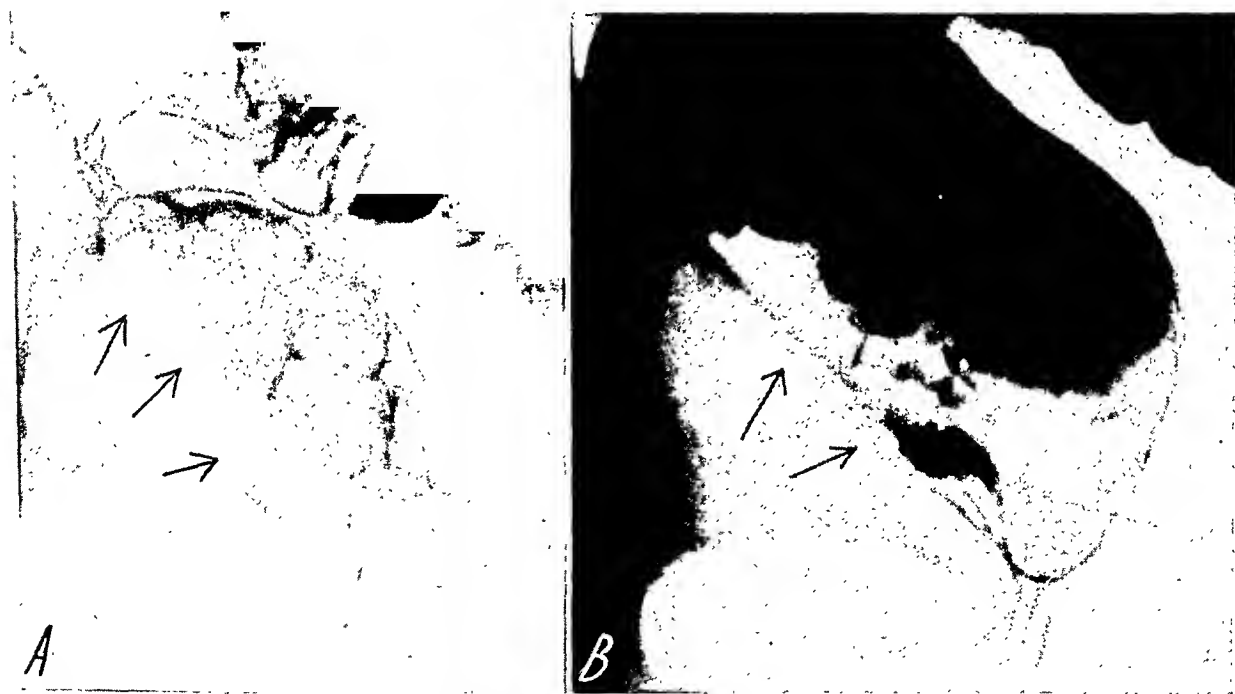


FIG. 3. Papillary type of cancer of rectum at various stages of filling. This illustrates how easily the distribution of the opaque medium in the rectum can be controlled.

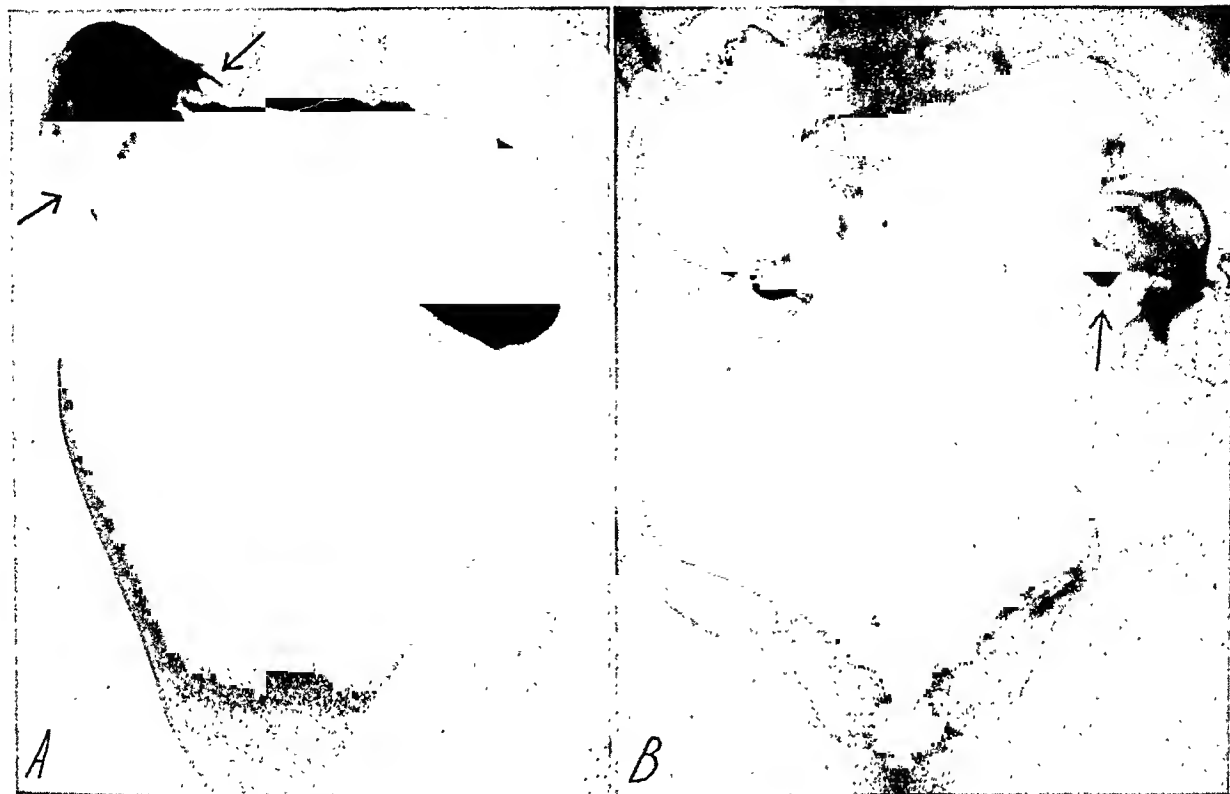


FIG. 4. During massive filling by means of the conventional enema technique (*A*), retrograde intussusception of the constricted segment takes place (arrow points to the characteristic filling defect resembling the figure 3). By means of the catheter method, the obstruction is overcome (*B*), and a small cancer crater is clearly shown (arrow).

of about 12 degrees and is centered on the midline about 1 inch cephalad of the pubic symphysis. Since the rectum is closer to the posterior than to the anterior border of the pelvic cavity, this projection usually produces good definition. (2) The patient is supine but with the right side raised by about 45 degrees; the tube is directed vertically downward to a point about midway between the umbilicus and the left inferior iliac spine (corresponding to McBurney's point, but on the left side); the left leg is bent at the hip joint, and the right leg is extended and brought backwards as far as possible, in order to avoid obscuring of the rectum by the summation of the shadows of both thighs (Fig. 2). In this position the rectum and sigmoid are nearly parallel to the plane of the film.

*Comments.* An enema is not made more pleasant when taken in an ill-lit room, on a hard table, and in the presence of a stranger armed with a leaden glove. Making the pa-

tient feel comfortable is perhaps the most important single factor in obtaining satisfactory diagnostic results.<sup>1,4</sup> Using effective cleansing measures without causing irritation of the bowel is almost equally important. The only disadvantage of the catheter method is that the catheter has to be held in place during roentgenoscopy. The main advantages are: (1) the flow and distribution of the opaque enema can be controlled so accurately that degrees of filling ranging from slight mucosal coating to massive distention of the rectum can be obtained (Fig. 3); (2) there is no distress even in the presence of painful lesions of the anus and rectum; (3) stenosis is usually overcome by the slow and regulated flow of the medium through the catheter, while it is often accentuated during massive filling, since the sudden pressure of the opaque medium upon a narrowed segment may cause retrograde intussusception and complete occlusion (Fig. 4).



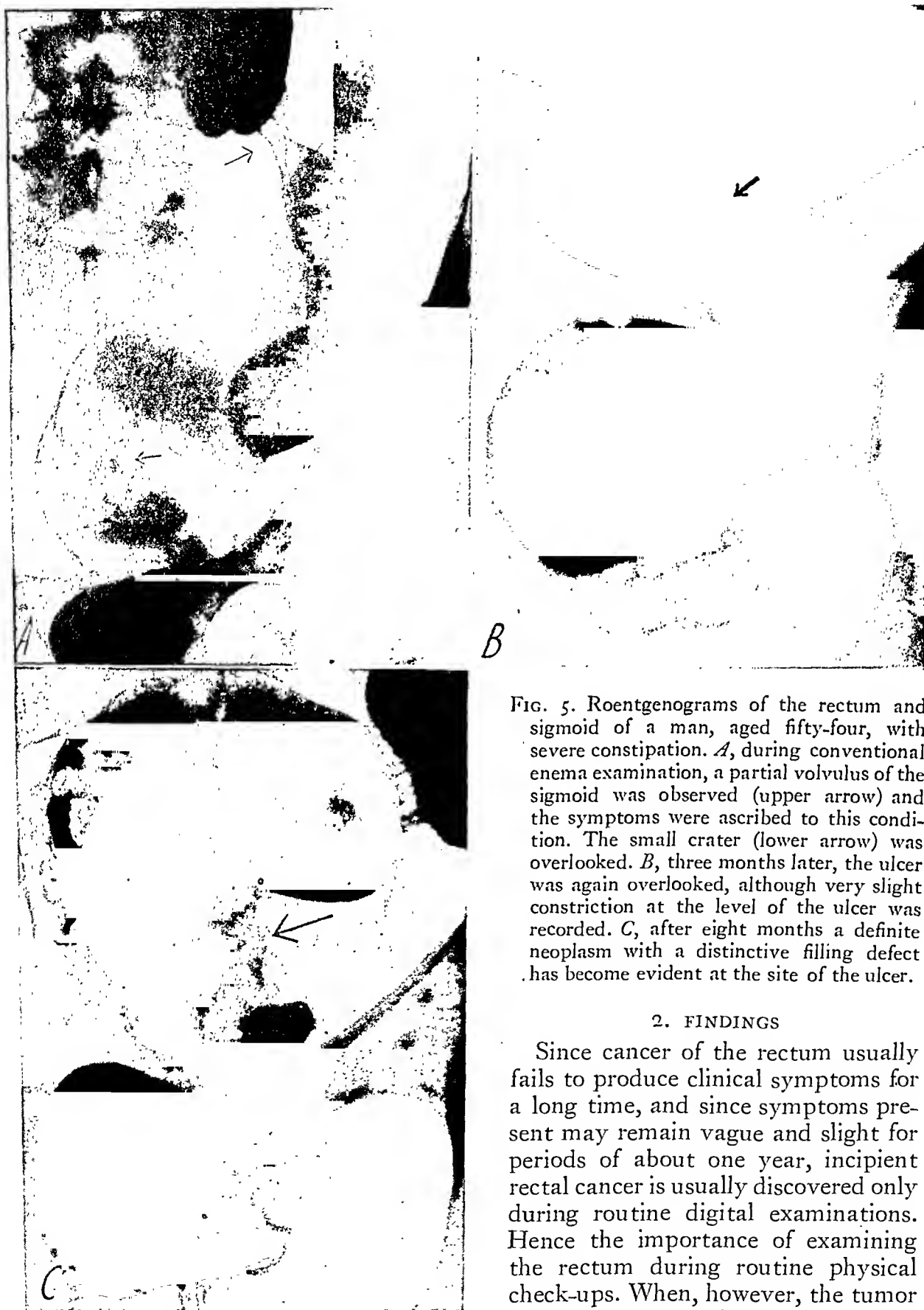


FIG. 5. Roentgenograms of the rectum and sigmoid of a man, aged fifty-four, with severe constipation. *A*, during conventional enema examination, a partial volvulus of the sigmoid was observed (upper arrow) and the symptoms were ascribed to this condition. The small crater (lower arrow) was overlooked. *B*, three months later, the ulcer was again overlooked, although very slight constriction at the level of the ulcer was recorded. *C*, after eight months a definite neoplasm with a distinctive filling defect has become evident at the site of the ulcer.

## 2. FINDINGS

Since cancer of the rectum usually fails to produce clinical symptoms for a long time, and since symptoms present may remain vague and slight for periods of about one year, incipient rectal cancer is usually discovered only during routine digital examinations. Hence the importance of examining the rectum during routine physical check-ups. When, however, the tumor has its seat at or slightly cephalad to

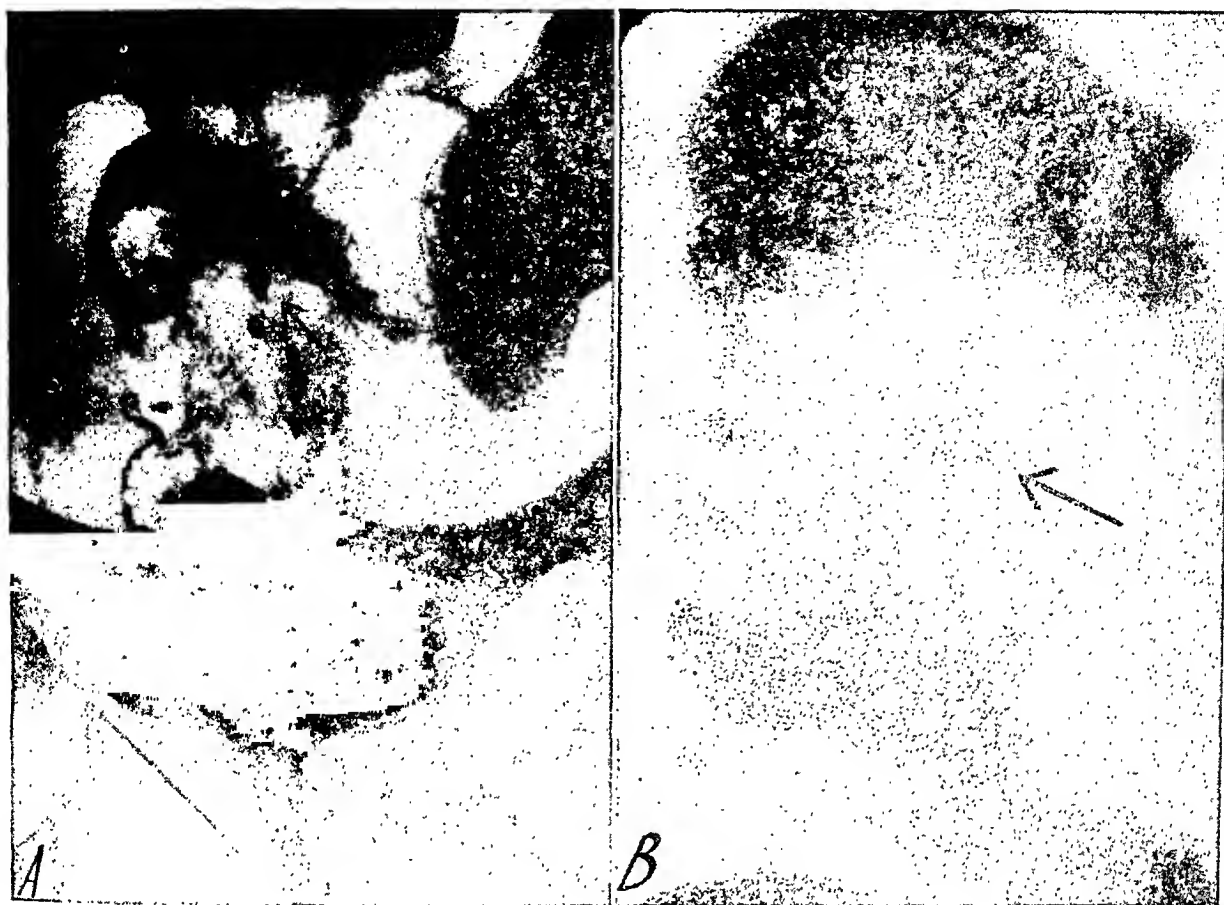


FIG. 6. *A*, anteroposterior, and *B*, oblique projections, showing a cancer crater close to the proctosigmoidal junction (confirmed histopathologically).

the proctosigmoidal junction, it may escape the palpating finger, and proctoscopy is then omitted in most cases. A certain number of cancers of the proctosigmoidal junction are not accessible to the proctoscope. For all these reasons, it is good practice to make a study of the rectum during routine roentgen examinations of the digestive tract. The additional time spent rarely exceeds five minutes. A number of cancers at early stages were discovered in the rectum in this way before being suspected clinically.

The roentgenologic appearances vary with the anatomical nature of the tumor. The large majority of rectal cancers are of the annular ulcerating type; next in incidence are cancers arising in polyps; papillary cancers are relatively rare. All age groups are involved. In this series the incidence was highest between the ages of

forty and fifty-five years and almost the same in males and females.

1. *Annular Type.* The appearances observed at early stages do not conform to those of more advanced annular cancer. Filling defects and shelf formation are rarely present, and constriction is often so slight as to remain unnoticed, if present at all. The involved segment is easily distended during massive filling, and the absence of constriction and deformity during massive filling was responsible for diagnostic failures during the early stages of this study (Fig. 5).

There is, however, one constant sign, namely, a small ulcer with rigid walls. The ulcer produces appearances very similar to those of peptic ulcer of the duodenum. It is seen as a persistent opaque spot 1 to 2 mm. in diameter when projected endwise, and as a thorn-shaped prominence of the contour

when projected edgewise, with the thorn pointing outward. The lesion is not definitely intraluminal, and the appearances do not correspond to the meniscus sign of early gastric cancer, except at a more advanced stage (Fig. 8). The mucosal pattern may appear to be erased in the immediate neighborhood of the ulcer (Fig. 4, 5, 6 and 7).

As the tumor grows, constriction becomes evident, and there may be nodular prominences encroaching upon the lumen (Fig. 5). The findings observed at these more advanced stages are well known and need not be described here.

Among the last 52 proved cases of annular rectal cancer of this series, an ulcer was seen roentgenologically and confirmed pathologically in 50 patients; the lesion escaped roentgenologic demonstration in 2 instances; and there were associated signs of tumor, such as shelf formation, constriction, and filling defects, in 11 cases. There was often a remarkable similarity of the anatomical and roentgenologic appearances.<sup>4</sup>

The term "annular," used in textbooks, is somewhat misleading. These tumors are annular at advanced stages, when they involve the whole circumference of the rectal wall; but they are definitely not ring-shaped, or annular, at incipient stages, when they are confined to only a sector of the rectum. These early lesions always show a central ulcer; and although the crater is merely the earliest roentgen sign, but not necessarily the earliest anatomical evidence, of this type of carcinoma, the consistent presence of an ulcer in these cases would seem to justify the term "ulcerative" carcinoma, rather than annular carcinoma.

2. *Papillary Type.* There were only 3 cases in this series, and none of them was very early. The papillomatous shape of the tumor is readily recognized by the scalloped irregular filling defect which seems to arise from a circumscribed area, usually in the lateral wall of the rectum, without producing obstruction. Ulcers may be present in



FIG. 7. *A*, cancer crater at the proctosigmoidal junction. There is slight constriction of the involved area. *B*, small crater at the site of an anastomosis made two years previously for cancer of the proctosigmoidal junction. The crater was found to correspond to a recurrence of the cancer.

these cases (Fig. 3). Owing to the absence of constriction, the involved segment remains flexible for a long time, and is readily distended during massive filling. When these tumors are located along the posterior wall of the rectum, they are easily overlooked.

4. *Carcinomatous Polyps*. Polyps may occur either in the form of polyposis or as single polyps scattered thinly over a part of the pelvic colon. Polyposis is easily recognized by the characteristic chain of filling defects which it produces.<sup>4</sup> Single polyps in the rectum are difficult to see roentgenologically. True polyps, which are neoplasms, cannot be distinguished from so-called secondary polyps, which represent localized hypertrophy of the mucosa as a result of chronic inflammation. Since a majority of true polyps prove to contain foci of carcinoma histopathologically, it is important to discover these tumors before they have become frank cancers.

Single polyps cannot always be recognized by palpation and proctoscopy since they may become buried between loose or large mucosal folds. In 4 cases, single polyps, not previously disclosed by digital examination and proctoscopy, were revealed by roentgen examination and subsequently confirmed by proctoscopy and biopsy; all of them were malignant (Fig. 9A). The rounded filling defects caused by polyps, easily recognized with slight filling of the rectum, are usually invisible during massive filling (Fig. 9B). The outlines are smooth and clean-cut, no matter whether the polyp is benign or histopathologically carcinomatous, and it is not until infiltration and ulceration set in that the malignancy of the lesion becomes evident roentgenologically.

### 3. DIFFERENTIAL DIAGNOSIS

When the lesion involves the ampulla of the rectum, a differential diagnosis can be made by proctoscopy and biopsy in many cases; moreover, there are few diseases which have to be considered. Internal hemorrhoids may cause filling defects resembling polyps; but the worm-like shape of



FIG. 8. Moderately advanced annular cancer of the proctosigmoidal junction, showing a central ulcer (arrow) with tumor-shelf formation on both sides.

the filling defect is usually revealed by views taken at various angles.<sup>4</sup> Villous proctitis, a relatively rare condition, may cause similar appearances but involves a much larger area than does cancer.<sup>4</sup>

Cancer of the proctosigmoidal junction is often inaccessible to proctoscopy and biopsy, and the fact that benign lesions of this region are common adds to the diagnostic difficulties. Both benign and malignant diseases of this segment tend to cause constriction and pericolic adhesions with deformity and rigidity of the walls. The crater produced by incipient cancer may become lost in the irregularity of the contours; on the other hand, a tent-shaped adhesion may simulate a tumor crater, especially in a constricted area (Fig. 10A). Suppurative pericolicitis may produce appearances strongly resembling those of cancer, since the pressure defects caused by small intramural or pericolic abscesses obliterate the mucosal pattern and pro-

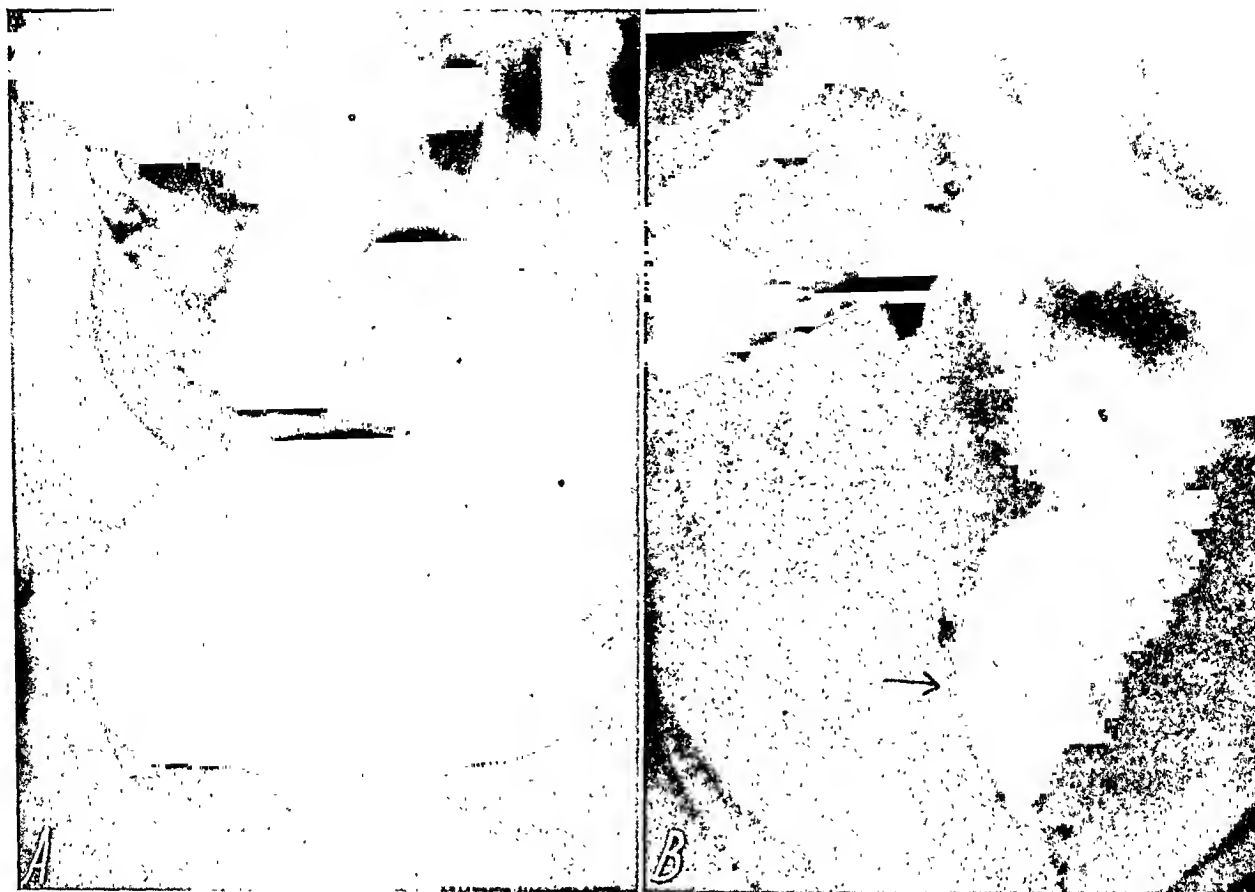


FIG. 9. Polyps of the rectum, histopathologically malignant. *A*, the polyps are not seen during massive filling with the conventional enema technique. *B*, the polyps are well shown with the modified method. These polyps had not been discovered previously during proctoscopy because they were hidden between large mucosal folds.

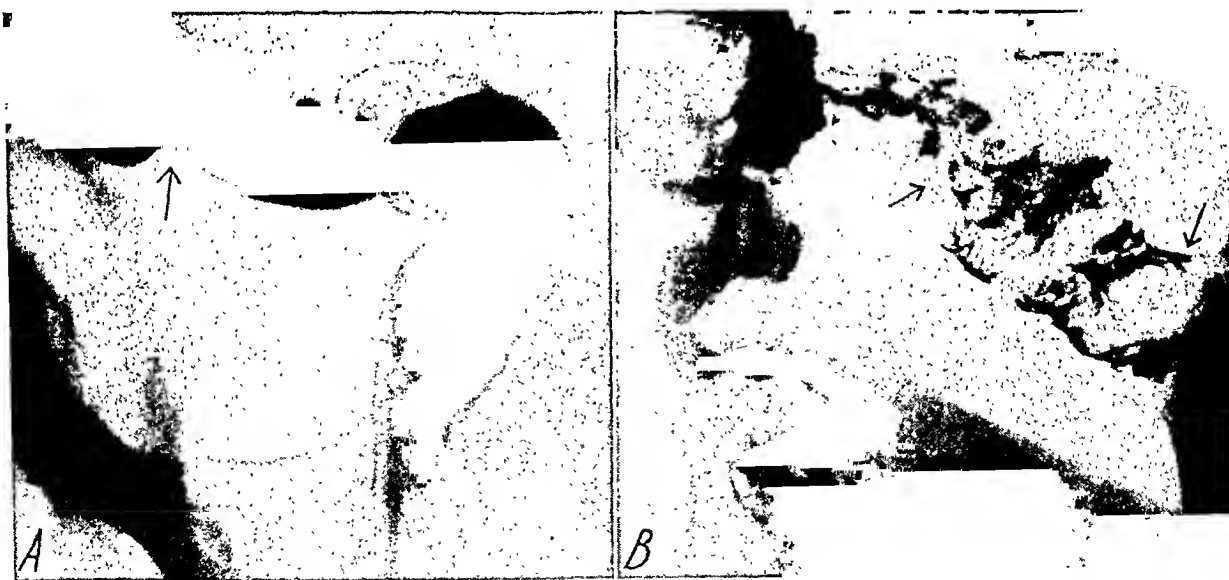


FIG. 10. Suppurative pericolicitis. *A*, a small adhesion (arrow) simulates a tumor crater. *B*, multiple filling defects (arrows) caused by small pericolic abscesses in the sigmoid.

trude into the lumen like tumor nodes (Fig. 10*B*). If there are normal areas between these formations, cancer can usually

be ruled out. Since in the presence of suppurative pericolicitis surgical operation involves the risk of setting up diffuse peri-

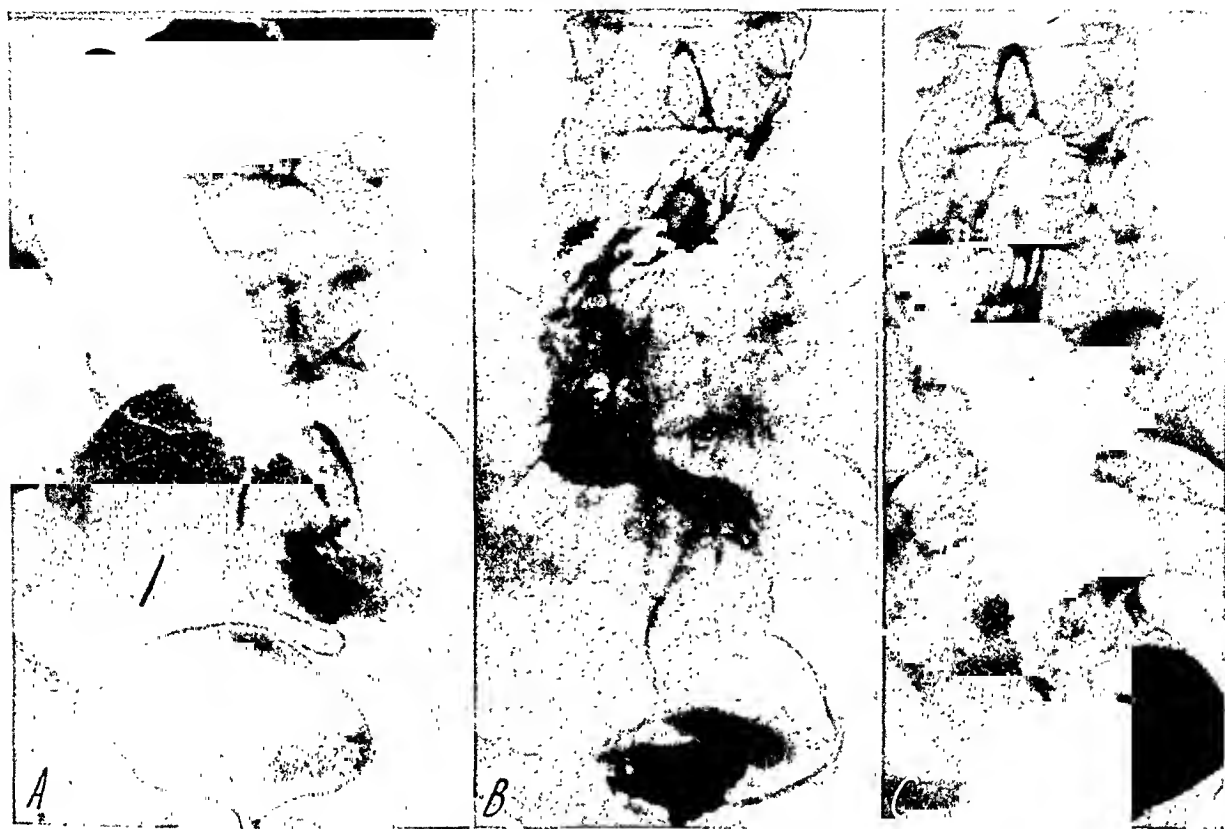


FIG. 11. Constriction of proctosigmoidal junction caused by colitis. *A*, during massive filling, and *B*, with the modified technique, a persistent narrowing of the proctosigmoidal junction is disclosed. *C*, one month later, after dietary treatment, the constriction has disappeared, and the mucosal relief of the sigmoid, coarse and irregular in *B*, has become normal.

tonitis, and since pericolitis, unless it causes obstruction, rarely requires surgical intervention, it is important to differentiate the condition from tumor.

Subacute and chronic inflammation of the proctosigmoidal junction, with or without diverticulitis, differs from cancer by the presence of persistently thickened mucosal folds.<sup>2,4</sup> Sometimes a circular constriction of the colon is present in these cases and subsides when the inflammation heals (Fig. 11). Stenosis of the rectum due to venereal lymphogranuloma can hardly be confused with tumor.<sup>3</sup>

In elderly people the distal end of the rectum often bulges concentrically around the internal sphincter, thereby producing, so to speak, an "internal prolapse."<sup>4</sup> The internal sphincter then stands out as a deep circular constriction which, together with filling defects caused by hemorrhoids, may produce appearances suggestive of annular tumor (Fig. 12).

#### 4. CONCLUSIONS

The factors involved in improving diagnostic results are not solely technical. For instance, when incipient cancer of the rectum has been detected roentgenologically in a number of cases, the resulting increased interest of physicians and surgeons leads almost inevitably to a more thorough search for these tumors during routine physical examinations. Consequently the significance of roentgen examinations in the early diagnosis of cancer of the rectum is difficult to evaluate; but the fact that in a group of patients cancer of the rectum was discovered during roentgen studies of the digestive tract before being recognized by other clinical methods suggests that roentgen examination has its place in the early diagnosis of this disease. This does not by any means imply that roentgen examination is superior to digital and proctoscopic examinations. The point is that cancer of the rectum remains clinically silent for a

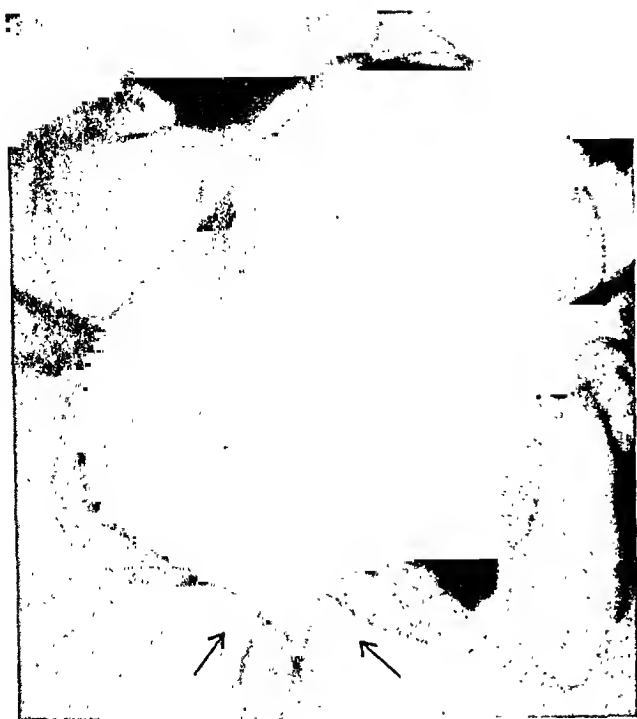


FIG. 12. "Internal prolapse" of rectum around internal sphincter in a woman aged sixty-three. The lower part of the rectum overhangs the internal sphincter (arrows). This may simulate annular constriction. See text.

long time, wherefore its incipient stages are usually discovered almost accidentally, during routine examinations. One of these routine examinations is roentgen study of the digestive tract. Consequently the roentgenologist should make an adequate study of the rectum during every examination of the digestive tract. The importance of this rule is illustrated by the fact that in a small community, with a 100-bed hospital, cancer of the rectum has been demonstrated roentgenologically at an average of 1 case in every nine days during a period of two years.\*

Perhaps the roentgen findings obtained with the modified enema technique above described can be duplicated with the conventional opaque enema methods; but the modified method seems to disclose significant details with greater ease and accuracy. Whatever method is used, adequate cleansing of the bowel, prevention of motor

\* All the cases of this series were verified histopathologically. Most of the histopathologic examinations were made by Dr. Ralph E. Miller, professor of pathology, Dartmouth Medical School; and in 2 cases, by Dr. Tracy B. Mallory, pathologist, Massachusetts General Hospital.

irritation of the rectum, and an intelligent approach to the patient are important factors in obtaining satisfactory diagnostic results.

## 5. SUMMARY

1. Roentgenologic demonstration of small lesions of the rectum is facilitated by the use of an opaque enema technique so modified as to achieve accurate control of the distribution of the opaque medium in the rectum and sigmoid.

2. The most constant sign of incipient annular cancer of the rectum is a small ulcer with rigid walls. Other signs of tumor, such as constriction and shelf formation, are rarely present at early stages.

3. Malignant polyps and small annular cancers, not previously noted during digital and proctoscopic examinations, were disclosed roentgenologically in a number of instances. This suggests that roentgen examination with an adequate technique has its value in the early diagnosis of these tumors.

4. Roentgenologic appearances simulating tumor may be produced by suppurative pericolicitis.

5. Since cancer of the rectum usually remains clinically silent until it has reached a relatively large size, incipient stages are discovered mainly during routine examinations. Consequently routine roentgen studies of the digestive tract should include an accurate examination of the rectum in every instance.

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# CLINICAL AND ROENTGEN ASPECTS OF IRRADIATION STRICTURE OF THE RECTUM AND SIGMOID ITS COURSE AND TREATMENT\*

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BOWEL damage following irradiation for cancer of the cervix has by now been sufficiently described in the literature to be clearly established as an entity. Corscaden, Kasabach and Lenz,<sup>1</sup> Todd,<sup>2</sup> White,<sup>3</sup> Martin,<sup>4,5</sup> Chydenius,<sup>6</sup> Aldridge,<sup>7</sup> Wigby,<sup>8</sup> and others, have taken up variously the surgical findings, barium enema and proctoscopic appearances, related dosage techniques, pathological findings, possible methods of avoidance, and estimates of incidence of the condition. The greater number of these topics will be omitted from the present discussion, which will be limited to a functional study of types and degrees of damage of the bowel, our methods of handling the cases, and the results of treatment. We are concerned in presenting particularly the non-operative management of this condition, which in its severer forms has in the past been for the most part treated surgically.

Our material consists of 44 cases of temporary or permanent stricture of the bowel, in all but a few instances confined to the pelvic colon and rectum. Forty-two of the cases originated in the Woman's Hospital. Aldridge has reported on this material from the points of view of a general description of the condition, statistics as to occurrence and outcome, irradiation and surgical techniques, surgical-pathological findings. Those interested in this omitted background of our cases, including details of irradiation techniques, are referred to his paper. A brief discussion of incidence, though covered in the Aldridge paper, seems indicated because it bears on the nature of our material. He reported 16.9 per

cent of bowel injury cases in the group studied, which is higher than the other series reported, and he described 29 cases of temporary or permanent stricture, of which 11 were operated upon. Since his paper was published we have added 15 more cases, of which only 1 has been operated upon. We feel sure that quite a few of our cases, among those designated as in Groups I and II, would not have been discovered if we not been particularly engaged in looking for them, and that otherwise our incidence would have been much lower. From subsequent experience we also believe that operation could have been avoided in several of the 12 cases operated upon, for reasons to be developed below, and this would have lowered our operative percentage. Wherefore we feel that statistics of incidence mean very little in this condition, unless barium enema studies and proctoscopies are done on every case with the slightest degree of diarrhea or other bowel complaint, which is obviously impossible of realization. A stricture relatively or entirely symptomless may be discovered, often accidentally, after five or eight or twenty-three years, as happened among our cases. A severe degree of narrowing may disappear completely within a year, while another case, with only mild bowel complaints for several years, may suddenly precipitate into acute obstruction, though this delayed outcome is rare. Further, a comparison of complications between clinics recognizing this entity and those which do not is misleading. All clinics reporting on cervical cancer note bowel complications. For example, Sackett<sup>9</sup> in a study of compli-

\* From the Clinics of Gastroenterology and Roentgenology, Woman's Hospital, New York. Read in part before the Forty-Third Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 15-18, 1942.

cations in 688 cases of cervical cancer treated at the Woman's Hospital from 1919 to 1935 lists the following:

	Cases	Per Cent
Intestinal-vaginal fistula	60	8.7
Intestinal obstruction	25	3.6
Rectal disorders	42	6.1

He admitted that there was overlapping in these groups. Some of the rectal disorders with diagnoses founded on severe diarrhea, rectal bleeding, tenismus, cramps, and so forth, might well pass over into obstruction or fistula. But we believe that, if metastasis of the bowel is excluded, all or nearly all of the remainder of the above cases would at some time in their course have shown pictures similar to those described here. Practically all of the cases here to be discussed were treated subsequent to 1935, and do not overlap those in his report, and it is interesting to note that in our material fistulae have almost disappeared, suggesting that prompt treatment of a local focus of injury aids in preserving the blood supply and healing the ulceration, and hence in preventing development of fistulae. We feel strongly that the apparent upsurge of intestinal stricture, whether or not related to specific techniques, is no new entity, but merely one more sharply diagnosed. Cancer is a lethal disease, and its treatment, no matter how carefully done, cannot always be harmless to surrounding structures, as all of us know who are confronted from time to time with permanent skin damage, lung fibrosis, necrosis of bone and cartilage, to name but a few sequelae of irradiation of cancer in other parts of the body.

#### RELATION BETWEEN CURE OF PRIMARY DISEASE AND BOWEL DAMAGE

In general, the management of bowel damage tends to be a problem of the cured case,—cured, that is, of local cancerous disease. This point was made in respect to irradiation ulcer of the bladder, another casualty of cervical irradiation, by Dean in a symposium at Memorial Hospital on bladder and bowel injuries following pelvic irradiation. In his experience the bladder

ulcer of this type was most frequently found in a pelvis free of cancer, the assumption being that irradiation heavy enough to injure the bladder was likely to cure the cancer. This reasoning cannot of course be applied too literally, as many cured cases do not have ulcer of the bladder, or intestine, and some visceral damage is due to faults of technique, adhesions and other causes than the mere fact of irradiation. Nevertheless there is a trend in our series suggesting that damaged bowel tends to occur in cases in which the pelvic disease clears up following irradiation and does not recur, at least for the periods covered by our study. If this is substantiated by longer observation, it makes the matter of diagnosis and treatment doubly important. If a patient is to live free from her cancer, but troubled by a bowel disorder, she does not consider the outcome successful even though she appears on the five year cure list of her particular clinic. In reading over old charts from the group cited by Sackett in his Complications Report we were impressed by the probability that at least some of these patients dying of intestinal hemorrhage or obstruction, assumed to be due to the spread of cancer, actually had hemorrhage from irradiation ulcer, or obstruction from

TABLE I

#### STATUS OF PELVIC CANCER IN CASES WITH BOWEL DAMAGE

1. Cases living	29
No clinical evidence of pelvic cancer	28
(Cases under one year—3)	
Pelvic cancer present	1
2. Cases dead	15
No evidence of pelvic disease at death	11
Pelvic cancer present	4
3. Causes of death where there was no pelvic disease	
Remote metastasis	4
Hemorrhage from ulcerated bowel	2
Postoperative peritonitis	2
Starvation	1
Cardiovascular disease	2
4. Total cases followed over one year	41
5. Primary regression of cervicopelvic cancer	36

irradiation stricture, together with peritonitis from perforation of a non-malignant ulcer. Table I shows the basis of our belief that bowel damage tends to be accompanied by success in the immediate treatment of the local cancerous disease.

Thus, in 41 cases followed over one year, 1 is alive with pelvic cancer, and 4 died of it. Thirty-six cases with bowel damage, or over 90 per cent of the group, showed successful regression under treatment and with 1 exception remained free of demonstrable pelvic disease to the present. This percentage of course has nothing to do with five year survival rates, as, at the time of preparation of this table, only 9 cases had been followed more than four years. It is offered merely as an index, in an admittedly small group, of a possible relation between bowel damage and successful local treatment of the cancer.

#### LOCATION OF BOWEL TRAUMA

Contrary to the experience of some workers, we have had no cases of massive widespread ileal damage. This is undoubtedly a product of heavy roentgen dosage, almost invariably through large portals involving large cubic areas of capillary bed, with correspondingly extensive damage of the blood supply. Our largest individual roentgen portals measured  $12 \times 16$  cm., and 7 of the cases had radium alone, 37 radium and roentgen radiation. Involvement of the ileum for short segments was demonstrated in only 6 out of 44 cases, 2 of ileum alone, and 4 in combination with a segment of large bowel. The ileal damage in all 6 cases was localized in or near the midline, and at the cervical level. In every case the ileum was adherent in the pelvis, to a loop of sigmoid usually, once to the uterus, and once bound down firmly to a pus tube. All ileal lesions were discovered at operation. One could have been discovered on the roentgenograms, where a gas-filled coil of ileum maintained a constant fixed position in relation to strictured sigmoid, but it was missed at the time. In 42 cases, the damage was predominantly in the large bowel, solely in

38, and combined with a short piece of adherent ileum in four. More detailed location of the injury is given in Table II.

TABLE II

#### LOCATION OF INJURED BOWEL SEGMENTS

Rectum alone	1
Rectum and rectosigmoid junction	3
Rectosigmoid and adjacent distal sigmoid	17
Mid-sigmoid, short segment	3
Proximal sigmoid, short segment	1
Long strip of sigmoid	8
Ileum alone	2
Two or more areas of narrowing (1 area ileum, 1 sigmoid,—4)	9

It will be seen that the large bowel injuries are limited further to the rectum and sigmoid, with the greatest number in the distal sigmoid and at the rectosigmoid junction. The validity of some of the divisions as to distal, mid and proximal is questionable, as the coils shift and turn on one another according to degree of filling and change of positioning in roentgenograms. They are given for an average appearance on a number of roentgenograms, but cannot be considered as arbitrarily fixed. It is obvious from the table why a complete picture of the lesion cannot in many cases be obtained by proctosigmoidoscopy. The instrument passes only to the first point of narrowing. The extent of the stricture, or the presence of a second stricture proximal to the first, can be discovered only by the use of a thin barium stream through the canalized areas.

Our lesions then are predominantly in the midline; all are included in an arc 5 to 6 cm. from the midline and the cervical level, where summation of irradiation effect is obtained with our techniques. Most writers on the subject offer suggestions and individualized techniques for avoiding such injuries, but it is difficult to see how they can ever be completely eradicated as long as we continue to try to administer a dose of 7 or more threshold erythema doses to areas of pelvic cancer. There will always be a few cases with pieces of intestine adherent to the uterus, or bound down close to it against other structures, or gas-distended

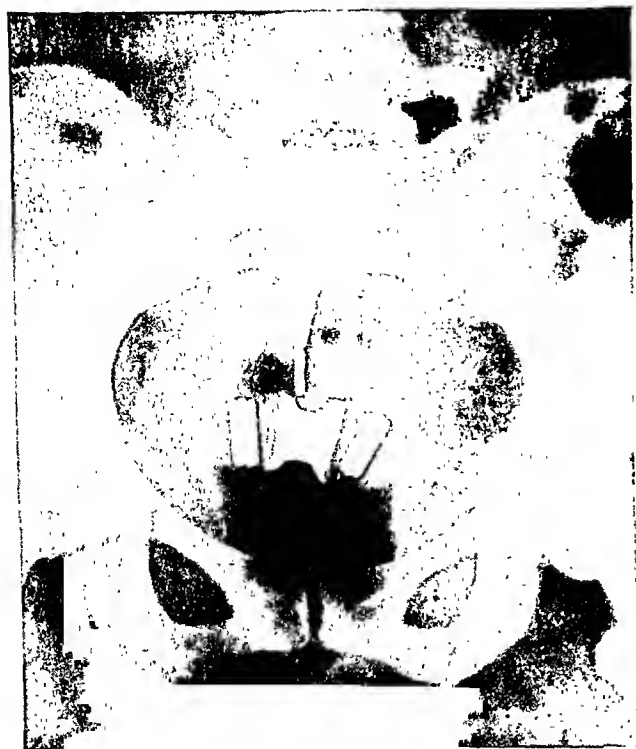


FIG. 1. Rectum and distal sigmoid distended by gas, their anterior walls obviously close to the cervix. This confirmed by lateral view, not shown here. Applicators are of the Manchester type. Case from the New York Infirmary for Women and Children.

loops of sigmoid thrusting themselves close against the radium source in the cervix. Two roentgenograms illustrate the last named effect. Figure 1 shows the location of applicators, and adjacent gut distended by gas. Figure 2 shows the resultant injury diagnosed by enema ten months later.

#### INITIAL TREATMENT PROCEDURES

Our study of this condition has been carried on for seven years. The first cases we discovered were sent for obstruction supposedly due to spread of malignancy. Cases of rectosigmoid irritability with symptoms of diarrhea, bleeding, tenesmus, cramps, and a clinical diagnosis of "irradiation proctitis" were next differentiated. Sometimes a localized narrowing was found, sometimes a more generalized but transient spasm, sometimes where the symptoms were mild, nothing more than a little mucosal hyperemia. For a while we did barium enema and ileal studies on all cases of so-called "irradiation sickness," but this

proved unrewarding in proportion to the trouble and expense; it was soon abandoned, and comments on it are outside the scope of this report. Now the Woman's Hospital routine on all cases of cancer of the cervix includes cystoscopic and proctoscopic examinations before any irradiation is given. Several cases of low grade proctitis or cystitis have been found, and irradiation and follow-up is individualized accordingly. Another small but sometimes important item is the avoidance of routine administration of cathartics while the patient is in the hospital for radium treatment, and the forbidding of self-dosage during the ambulatory roentgen course. Too liberal use of milk of magnesia in the hospital was related to severe diarrhea immediately after radium treatment in 7 cases, with epsom salts and cascara implicated in 2 more. To be sure, the cathartic was not the primary case of actual bowel damage, but it was not soothing to an irritable bowel segment.



FIG. 2. Stricture diagnosed ten months later, exactly at level of radium applicators. Both mucosal ulceration and perirectal infiltration were present. Compare with Case II, Figure 4A, which shows similar type of lesion.

Other reflex sources of increased peristalsis, such as gallstones and duodenal ulcer, were present in a few patients, and 2 had hives, though any connection in the latter circumstances is highly questionable. Our system of treatment provides radium first in Stages I, II, and early III (Schmitz' classification); roentgen irradiation first in late Stage III, any badly infected cases, and in Stage IV for palliation with radium used later in Stage IV only if marked improvement occurs from roentgen irradiation; Stage V cases may be treated with either roentgen irradiation or radium, depending on their status, but not both. Where roentgen irradiation has been used first, no immediate bowel difficulty to interfere with subsequent radium has arisen. The reverse has not always been true. Four cases had such severe bowel reactions following radium that the roentgen radiation series could not be given, and in a fifth case, judged by hindsight, it should not have been given.

#### PATHOLOGICAL AND CLINICAL FEATURES

The primary damage in cases of gross bowel injury appears to be to the smaller branches of the hemorrhoidal vessels supplying the bowel, with thrombotic occlusion thereof resulting in infarction, and mucosal ulceration of the involved segment. Spasm further increases the ischemia so produced, which is not immediate but gradual, as areas of attempted repair are found with the necrosis. Obviously the cellular elements for this reaction must be supplied by some still functioning vessels, and the proportion of these determine the prognosis as to complete restoration, healing by fibrosis and scar, or perforation. The fibrotic changes may involve the bowel only, or may extend to the surrounding tissues with formation of a dense fibrous mass involving the structures of the lower pelvis, simulating the frozen pelvis of massive malignant invasion. Such an event adds greatly to the intrinsic luminal distortion.

The principal feature of the clinical picture is diarrhea, which may occur as early

as the third week after beginning of treatment or some months thereafter. This may be a mild disturbance with four to six stools daily containing mucus and blood; or there may be severe rectal pain, tenesmus and "bearing down" sensation in the lower abdomen with the passage of considerable gross blood or clots. With these severe cases, there may be anorexia, nausea, vomiting, and obstipation with abdominal distention, and it is this picture that suggests obstruction to the surgeon. The mechanism is intense edema and severe spasm of the involved intestine followed by a varying degree of fibrosis with luminal contracture which accompanies the localized acute sigmoiditis and perisigmoiditis and its varying degree of ulceration. The latter may be severe enough to result in necrosis of the entire thickness of the bowel wall with resulting leakage into the peritoneum, vagina, or perirectal tissues to complicate the picture.

#### DIAGNOSIS

Such a development as the above has heretofore often spelled hopeless recurrence to the physician, who has relegated the sufferer to a "home for incurables," where abandonment of all but analgesic therapy has sacrificed the patient. We have infrequently (Table 1) seen neoplastic involvement of the bowel among such cases, some of who have come to operation or autopsy, with practically all of the remainder subject to continuous follow-up to the present. Obstructive symptoms with pain and rectal bleeding months after irradiation should therefore raise the presumption of irradiation effect until proved otherwise. A careful chronological history, roentgen studies by barium enema, sigmoidoscopy, and if possible biopsy should be employed in all cases. Functional bowel disturbance, dietary or cathartic insult, intercurrent intestinal infection and possible malignant disease may be differential alternatives to be considered and ruled out.

#### PROTOSCOPIC EXAMINATION

The rectal examination and proctoscopic

appearance may be striking. Since the lesions usually occur on the anterior wall of the bowel from 8 to 10 cm. from the anus at approximately the level of the cervix, or in the rectosigmoid or the distal sigmoidal loop, they are often subject to direct visualization. However, edema, spasm, and pain preclude viewing beyond the periphery of the involved area in many cases, and one must rely on roentgen examination.

In the milder reactions hyperemia, spasm, and increased mucous secretion are seen over the area, the membrane appearing like red velvet. There is friability to touch with easy bleeding on manipulation. Bullous edema, severe congestion, and multiple bleeding points may be seen scattered over a beefy red mucosa. When ulceration occurs there may be single or, less often, multiple areas of oval or irregular shape surrounded by a zone of hyperemia, the whole in a pale edematous plaque of indurated bowel wall of varying extent. The ulcer base is covered with grayish slough and the margins may appear somewhat raised and irregular. Its diameter may vary from 1 to 4 cm. Ulcers extending about the whole circumference of the gut as a band 4 cm. wide have been described. The induration will extend on the average over an area roughly double the area of the ulcer.

As healing occurs the slough separates and the ulcer shrinks. In the more caudad lesions on the anterior rectal wall, the eventual appearance is that of a pale, atrophic area the color and surface texture of a pigskin glove, spotted with small telangiectases. A puckered scar may mark the ulcer site, and here an irregular feel as of underlying scar bands will present itself to the examining finger. In the sigmoidal cases the caudal end of the involved area can be visualized as a fawn colored concentric contraction of the bowel. In severe cases with marked fibrosis of the perirecto-sigmoidal tissues, the rectum seems embedded as in a mould, which prevents instrumentation beyond the rectal ampulla. On palpation, a semilunar firm ridge may be felt at the fingertip extending in a band 1

or 2 cm. broad from one side of the pelvis to the other and representing thickened, contracted, fibrotic parametrial tissue. These are the cases that mimic massive neoplastic invasion of the pelvis. The most marked constrictive phenomena appear in higher lesions.

#### BARIUM ENEMA EXAMINATION

Types and variations of roentgen findings will be exhibited in the case material and illustrative roentgenograms. The barium enema technique is of diagnostic importance and will be described. Large, full enemata are no longer used, even though the strictured area is wide enough to admit them, first because it is usually easier to let barium run in from an elevated enema can than it is for the patient to expel it past a stricture, and second, because a rectum dilated by barium and barium-filled sigmoid coils overlapping one another may completely conceal a short stricture. We usually start with a pint or less of thin barium suspension, let it run in slowly under roentgenoscopic control, with the patient in the Trendelenburg position, until the stricture is reached, then let barium trickle past it if possible, to outline the extent of the stricture and to rule out a second strictured area higher up. We have never seen stricture as high as the iliac colon and prefer not to fill this part. In stout patients it may be necessary to increase the thickness of the suspension in order to get good shadows. Sometimes the barium runs in so freely that it cannot be completely controlled. Because of the stricture, whether spastic or fibrotic, these patients are often poorly prepared, and mottled gas shadows and irregular filling of this sort must not be confused with the raggedness of spasm or the atypical irregularities of some strictures. As to position for roentgenograms, direct anteroposterior or posteroanterior views are frequently non-diagnostic, and right or left oblique positions are required, depending on the location of the lesion and the position of the sigmoid coils. We have had cases in which the stric-

ture could be demonstrated only in a direct lateral view. It is preferable to make roentgenograms under fluoroscopic control, but at least the proper angles should be selected by fluoroscopy. Post-evacuation roentgenograms are desirable for comparison with the maximum attempted filling.

#### MEDICAL TREATMENT

Observation leads us to believe that in general this condition is self limited, and, barring certain untoward developments to be later considered, is best treated by conservative and medical means, applied with good judgment and individualization.

Bed rest with bland low residue diet should be employed during the severe symptoms. Since the nutritional state is often poor, an ample vitamin intake is indicated and we feel that this is best provided by appropriate concentrates rather than in the dietary, as fruit and plant substances are too stimulating to the bowel.

Antispasmodics should be given to full effect. Phenobarbital, other barbiturates, and a belladonna preparation in adequate amounts usually suffice and seem more satisfactory than the newer substitutes. For pain, acetyl salicylic acid with acetophenetidine and more powerful barbiturates will answer the purpose in most cases and should be tried before opiates are ordered. The latter may be necessary at times but should not be used routinely as they increase the tendency to distention and may break the compensatory effort of the bowel.

The bowel content should be kept soft to prevent irritating impaction above the involved area by appropriate dosage of liquid petrolatum products. Cathartics are interdicted.

A solution of 1 per cent tannic acid as a 6 ounce retention enema given daily at first, and later on alternate days, has proved useful, especially in limiting bleeding. Monsel's solution has been used for the same purpose. Starch water or mineral oil enemata may also be found soothing.

An amelioration of the edema and spasm may be anticipated with some natural di-

latation of the affected lumen by the fecal stream in time, and strict conservative treatment should be persisted in for some weeks after the initial improvement.

If there is frequent vomiting and progressive distention (and it is to be remembered that severe pain in itself will induce vomiting in many individuals) so that real obstruction is feared, preliminary roentgenograms of the abdomen for gas patterns and fluid levels should be made at intervals, since dilatation of the small intestine may occur with obstruction of the sigmoid. The state of body hydration and chemical balance should be observed by determination of the non-protein nitrogen, chlorides, carbon dioxide combining power and hemacrit readings, and any abnormality corrected. Transfusion of whole blood or plasma may be indicated. If evidence of true obstruction exists, a double lumen tube may be passed for decompression and emptying, and for the administration of fluid feedings such as milk, gruel and thick soups. If conservative means fail, this is good preparation for surgical treatment.

#### SURGICAL INDICATIONS

The application of surgery to these cases requires the greatest judgment. In general these patients are in poor condition and are not good risks. Indications for interference with consequent colostomy should be clear cut and not a matter of extemporization. In the past the following have been cited as calling for operative treatment: (1) obstruction; (2) severe repeated bleeding; (3) severe proctitis and intractable diarrhea calling for diversion of the fecal stream to promote healing; (4) marked weight loss; (5) prevention of perforation of necrotic bowel wall.

Of the 12 operated cases in our material there was only 1 with indisputable evidence of obstruction and this was ileal in origin. In the others with sigmoiditis there was no true evidence of obstruction in any case. Study of the clinical records shows that all either had spontaneous stools or adequate returns from enemata preopera-



tively. At least 8 were operated on in the acute phase of the inflammatory reaction. In some of these cases the surgery was frankly exploratory or for perforation. In several instances the surgeon's notes mention the threatening aspect of the barium enema findings and the striking narrowing of the stricture as indicating operation, but this has been shown to be insufficient evidence to warrant such a decision. Therefore, the conclusively established diagnosis of obstruction has not been a frequent indication for surgery in our experience. If established, its site must be recognized for in a case in our series where multiple lesions were present the lesion responsible for the condition was overlooked with consequent failure and death.

There were 2 postoperative deaths from massive hemorrhage from the bowel. In both, colostomy had been done and was inadequate to prevent the fatal outcome.

Proctitis, diarrhea and weight loss we do not feel indicate operation in the acute phase of the lesion until bed rest and careful conservative measures have failed.

It is difficult to see how one can anticipate perforation of the necrotic bowel before the event. If early perforation has occurred, colostomy alone will not solve the problem.

If after critical study operation seems called for, simple colostomy would appear to be the operation of choice in most cases. Resection with anastomosis has been successfully done, but the danger of anastomosing possibly ischemic bowel should be borne in mind. Abdominoperineal resection is considered an unjustifiably severe procedure except for the rare case. However, in the unusual patient, where repeated large blood loss might threaten an eventual fatal issue from massive hemorrhage, colostomy is obviously inadequate and some form of resection with removal of the damaged intestine is necessary.

#### CLASSIFICATION

For presentation of case material, some sort of classification is convenient, and we have adopted the following.

Group I. Temporary lesions, showing definite localized narrowing on barium enema and characteristic proctoscopic findings, wherein roentgen evidence of the lesion disappears completely or almost completely in a year or less, clinical subsidence by proctoscopy corresponds, and symptoms are of short duration.

Group II. Lesions rapidly becoming symptomless, in which slight, moderate, or rarely marked degrees of narrowing of the bowel persist longer than a year, and are presumed to be permanent. Here there is limited scarring and contraction without serious impairment of blood supply.

Group III. Severe grades of bowel injury, with enough impairment of blood supply to cause instability, without gross necrosis. Here are found varying degrees of permanent narrowing of the intestine, together with symptoms of bowel discomfort, usually intermittent. Breaks in compensation occur, due to the underlying status plus local factors of improper diet, lowered systemic resistance, remote reflex causes of spasm, and so forth, and a poorly nourished mucosa breaks down readily into ulceration, usually with intervening periods of healing. Occasionally these cases finally pass into Group IV with gross tissue breakdown.

Group IV. The most severe grade of damage, in which there is profound, though often narrowly localized, tissue destruction, with too much loss of blood supply to allow of adequate reparative processes for survival of the tissue. Necrosis, perforation, fistulae, peritonitis and severe hemorrhage are found, and surgical intervention in some form is generally required.

This classification is based on known or estimated degrees of blood supply impairment and tissue destruction plus the fact of outcome, after the passage of a reasonable period of time. It cannot be satisfactorily applied in the fresh case, where it is difficult to foresee the degree of response to be expected from treatment. Severity of initial symptoms is not a reliable measure of this. Our cases at the present writing are distributed as follows:

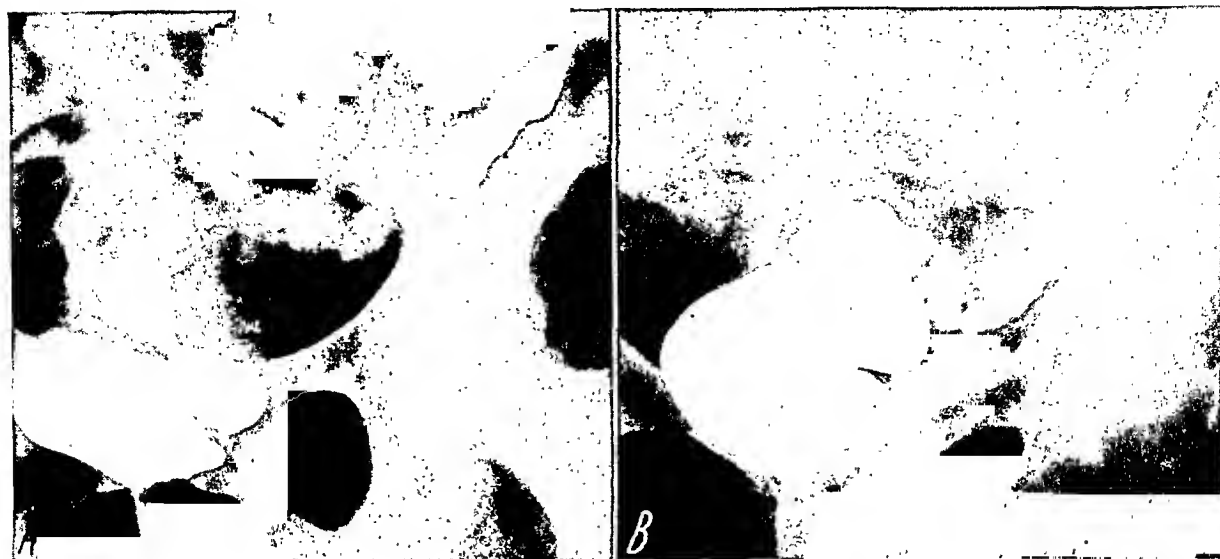


FIG. 3. Case 1. *A*, appearance of bowel in May, 1939, six months after completion of irradiation. *B*, August, 1942. No symptoms since three months after *A* was taken. Normal caliber of overlying coils of sigmoid confirmed by oblique views under fluoroscope. Last proctoscopy in March, 1943, showed normal appearance of bowel.

	Cases
Group I	4
Group II	16
Group III	5
Group IV	12
Early, under one year	7

The largest group is II, and this and Group I, a total of 20 cases, would probably not be included in any series based on severe morbidity of any great duration. We now feel that with our present experience in diagnosis and treatment some of the Group III cases could have been treated and ultimately placed in Group II, and that in a few of the operated cases, operation could have been avoided. Our fourth grouping is therefore ambiguous to the extent that it comprises the operated cases, supposedly representing the lesions of greatest severity, but in several of these the operative indications by our own criteria are now considered debatable. Others show irreparable tissue destruction, with hemorrhage or perforation or both, and the surgical indications are clear cut.

#### CASE REPORTS

##### *Group I. The Temporary Lesion*

This type of case may show initial proctoscopic findings ranging from mild to se-

vere, and almost any degree of bowel deformity by barium enema.

**CASE 1. H. A.** This patient is interesting because she presented several possibilities of future trouble even before she was given irradiation. She had had a supravaginal hysterectomy and salpingo-oophorectomy for chronic salpingitis seven years before, with multiple adhesions noted at operation. These stump cases offer the hazard of an adherent piece of intestine brought close to the radium source in the cervix, plus the likelihood of diminished screening of even non-adherent bowel by cervical tissue, especially at the point of excision. Also the patient had been admitted to a regular gynecological service, not the cancer division, where she had a curettage with removal of a cervical polyp and cauterization of the cervix. When the polyp was unexpectedly diagnosed malignant, she was treated with a single tube of 100 mg. of radium in the cervix and four 12.5 mg. needles surrounding it for twenty hours, a total of 3,000 mg-hr. This was followed by roentgen therapy, 150 r daily to each of two opposing fields 10 by 16 cm. each and excluding a strip 3 cm. wide in the midline, to a total of 2,000 r (measured in air) on each of four fields over a period of thirty-three days. She had liquid stools on the last four days in the hospital after radium treatment, being given milk of magnesia on the first two of these. After discharge from the hospital, small watery

stools with tenesmus continued for a short time, and a barium enema study was done, which showed moderate spasticity of the whole sigmoid but no definite constriction. Bowel function soon became normal with bland diet and the administration of paregoric and chalk, and the roentgen treatment was begun in two weeks, and concluded without discomfort. Her next

*Group II. Temporary Symptoms,  
Permanent Constriction*

As seen on roentgenograms the usual sequence in this type of lesion is for the area of damage, sometimes involving a considerable length of intestine, to diminish gradually in extent, the ends farthest from the

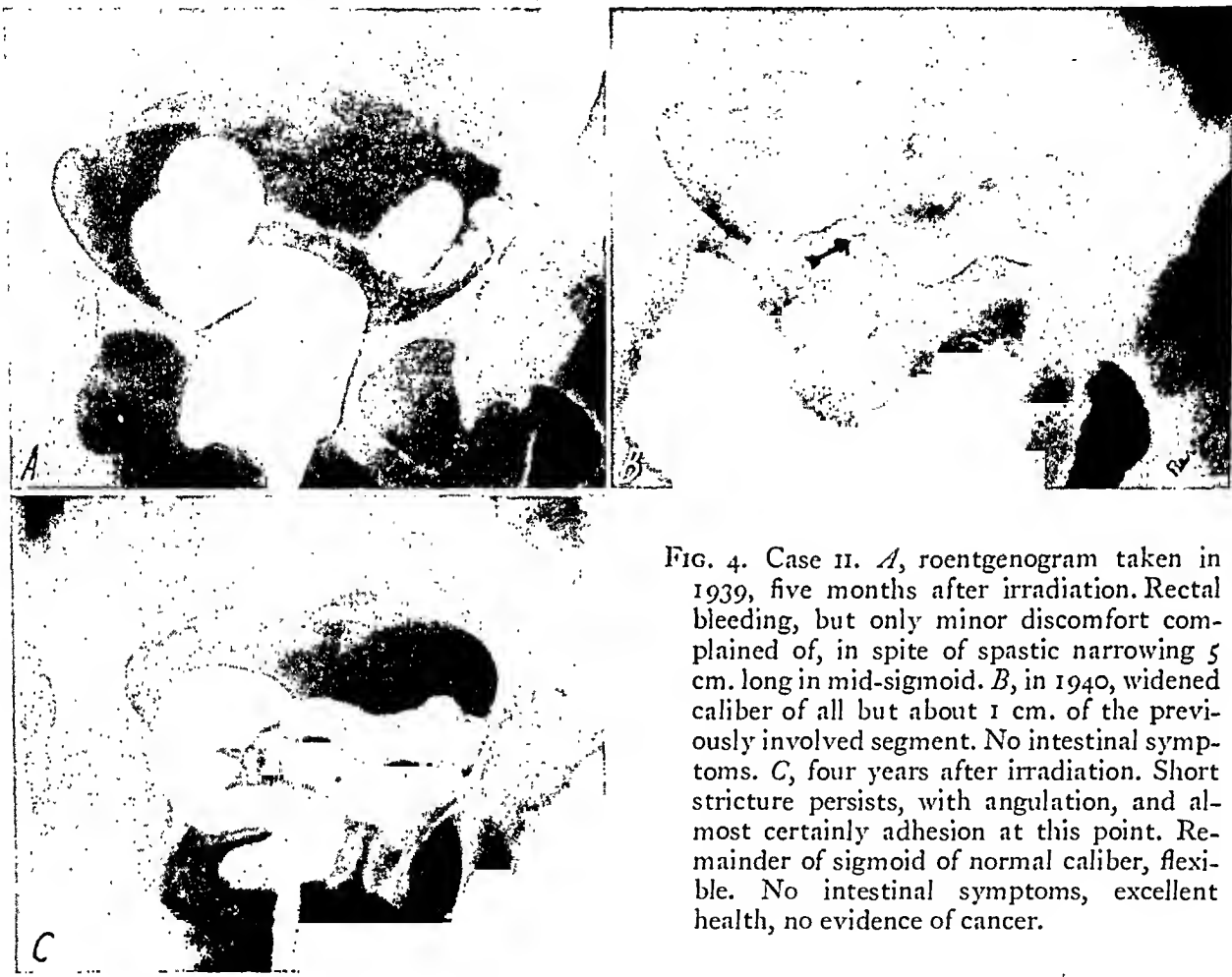


FIG. 4. Case II. *A*, roentgenogram taken in 1939, five months after irradiation. Rectal bleeding, but only minor discomfort complained of, in spite of spastic narrowing 5 cm. long in mid-sigmoid. *B*, in 1940, widened caliber of all but about 1 cm. of the previously involved segment. No intestinal symptoms. *C*, four years after irradiation. Short stricture persists, with angulation, and almost certainly adhesion at this point. Remainder of sigmoid of normal caliber, flexible. No intestinal symptoms, excellent health, no evidence of cancer.

complaint, of constipation, gas, and general distress in the lower abdomen, occurred seven months after radium treatment, five and a half months after the end of the roentgen irradiation. Barium enema at this time (Fig. 3*A*) showed a ragged, irregular narrowing of the sigmoid about 11 cm. long. The treatment was again bland diet and paregoric. Bowels were noted as improved after one month, with no symptoms three months later, or at any time in the subsequent four and a half years to date. A stabilized and normal sigmoid is shown in Figure 3*B*, three years after damaged bowel was demonstrated. The patient has been free of cancer for five years.

point of maximum irradiation first showing a return to flexibility and normal caliber, until after several years the residual fibrotic constriction may have decreased to 1 cm. or less in length. The greatest improvement comes in the first year and a half, but in a small group we have followed from four to eight years we have observed slow gains in flexibility and widened caliber up to three years, with little change thereafter. Two cases in this group will be shown, the first presenting spastic, edematous, ulcerating gut with no significant evidence of perisigmoidal reaction. The second shows

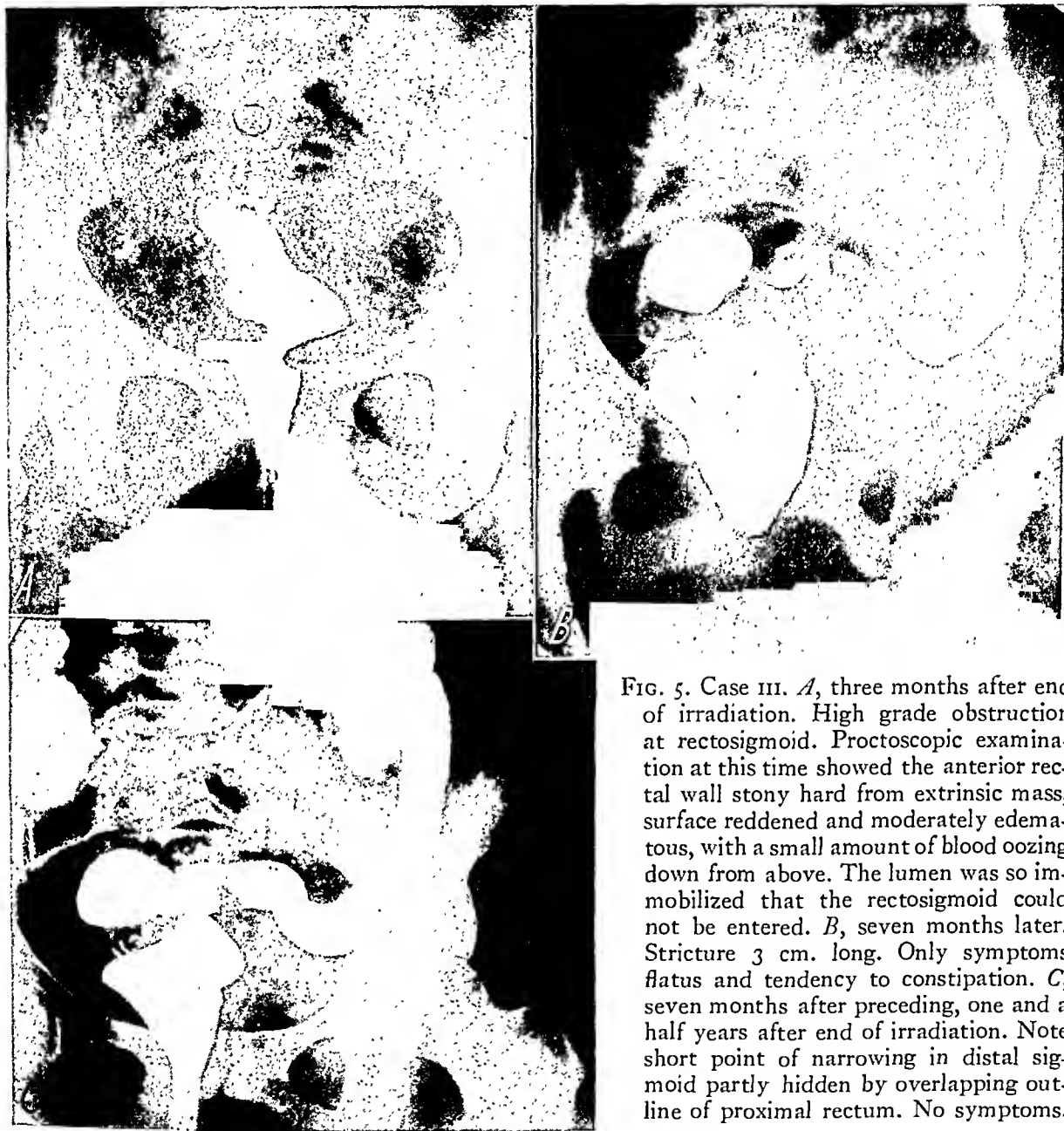


FIG. 5. Case III. *A*, three months after end of irradiation. High grade obstruction at rectosigmoid. Proctoscopic examination at this time showed the anterior rectal wall stony hard from extrinsic mass, surface reddened and moderately edematous, with a small amount of blood oozing down from above. The lumen was so immobilized that the rectosigmoid could not be entered. *B*, seven months later. Stricture 3 cm. long. Only symptoms flatus and tendency to constipation. *C*, seven months after preceding, one and a half years after end of irradiation. Note short point of narrowing in distal sigmoid partly hidden by overlapping outline of proximal rectum. No symptoms.

the typical "extrinsic" lesion described by Todd and others; though we do not consider the distinction between "intrinsic" and "extrinsic" of basic significance, except that the latter must be differentiated from the frozen pelvis of malignancy.

CASE II. B. E. This patient received the maximum irradiation usually given at the Woman's Hospital—6,000 mg-hr. of radium in the form of 100 mg. intracavitary and 6 needles totaling 75 mg. interstitially for twenty-four hours, followed in twelve days by the Ward colpostat using 75 mg. for twenty-four hours; roentgen irradiation consisting of totals of 1,800 r on

each of two anterior and two posterior pelvic fields, and 1,400 r on each of two lateral fields, a total of 10,000 r (measured in air) given to the pelvis. She had advanced disease when first seen, Schmitz Stage III, League of Nations' Stage III, squamous carcinoma, Grade 3, anaplastic. With all this, she seemed surprisingly spry and vigorous, whence an attempt at cure rather than palliation. While in the hospital she was another temporary casualty of the milk of magnesia routine with brief diarrhea which responded to paregoric and chalk, and with no subsequent complaint during roentgen irradiation or up to five months after the end of roentgen therapy and about seven months after



FIG. 6. Case IV. *A*, nine months after irradiation. Patient has recently recovered from an episode of bloody diarrhea. *B*, three years after irradiation. No acute symptoms at this time.

radium treatment. At this latter time, her clinic chart notes "occasional bleeding from rectum though bowels soft and regular with the aid of mineral oil." She was sent for barium enema study, which presented an appearance entirely disproportionate to her symptoms (Fig. 4*A*). She was put on a bland diet and the last sign of bleeding was a month later. Figures 4*B* and *C* show subsequent progress. She has had no further intestinal complaints for the past five years and there is no sign of cancer.

CASE III. M. E. This patient shows a different type of lesion and much more intestinal disturbance, though she had less radium, a total of 4,200 mg-hr. and less roentgen irradiation, 8,000 r (measured in air) to the pelvis, than the preceding case. She was readmitted to the hospital for obstruction three months after the end of irradiation, with symptoms of abdominal pain, distention, nausea, vomiting, and rectal bleeding. Perforation of the sigmoid from post-irradiation necrosis was considered by the surgeon. A cautious barium enema study was made with results shown in Figure 5*A*. She improved quickly on bed rest, low residue diet, mineral oil and sedatives, and operation was not required. After discharge from the hospital, the remaining symptoms gradually disappeared, except for gas and a tendency to constipation, for which she was kept on a bland diet with fruit juice for a considerable time. When seen recently, three years after irradiation, she had no complaints and was clinically free of cancer. The roentgenograms taken after barium enema are shown in Figures 5*B* and *C*. The clinical picture in this case includes features which some con-

sider criteria for surgical intervention and under other circumstances might have been so treated.

### *Group III. Permanent Stricture, Residual Symptoms*

This group is interesting because there are usually intermittent complaints alternating with symptom-free periods.

CASE IV. R. O. (From the New York Infirmary for Women and Children.) The patient had advanced carcinoma of the cervix, League of Nations Stage III. The left half of the cervix was stony hard, the left fornix obliterated, the cervical canal obstructed so that an intracavitary applicator could not be used. She was treated with a radium bomb delivering 1,500 mc-hr. in one hour eighteen minutes, and radon needles delivering 2,200 mc-hr. in thirty-six hours. The roentgen treatment was given over two fields daily with amounts ranging from 200 to 50 r each, the dosage being varied because of intestinal irritability, and a total of 2,000 r to each of four pelvic fields in thirty-eight days. The sequence was the radium bomb, part of roentgen cycle, radon needles, remainder of roentgen irradiation. Treatment was given in January and February, 1938. There was moderate intermittent diarrhea during irradiation and for several months thereafter, followed by a symptomless period, and then a sharp attack of bloody diarrhea six months after treatment. She had two such episodes in 1938, two in 1939; since then she has had constipation and cramps several times a year without bleeding. Her only other complaint during a four year period was the necessity for a peculiar bowel

routine consisting of morning sessions of repeated small evacuations, the whole performance lasting about an hour. (We have seen another case recently with stricture following the same scheme of six to ten small evacuations each morning taking one to two hours.) She took mineral oil, and by her own choice small doses of milk of magnesia. The patient remained clinically free of carcinoma for five and one-half years, until her death late in 1943 of a cardiovascular accident. Four barium enema studies were done in 1938, 1939, 1941 and 1942. Figure 6A shows the lesion late in 1938, Figure 6B shows it two and a half years later in 1941. The narrowest portion is no wider, but the length of the narrowed strip has decreased slightly, and this tendency is apparent also in the last barium enema examination made in 1942.

#### *Group IV. Severe Damage, Requiring Operation*

While we believe that unjustified surgical interference has occurred in cases of stricture, unavoidable indications for operation do arise. This is more likely to happen in the occasional late case where medical treatment has failed, the failure being based on irreparable bowel damage and evidenced by unremitting severity of symptoms of pain, diarrhea and bleeding, or by signs suggestive of perforation.

CASE V. L. E. This patient for over five years constituted a typical example, though unrecognized, of Group III. During that time she had intermittent attacks of pain, constipation and blood-streaked stools, occurring three or four times a year, with intervals of normal bowel state and excellent health. She had had radium treatment in 1933 for cervical carcinoma, but no roentgen therapy because of marked telangiectasis of the lower abdominal skin and dense pelvic fibrosis following an earlier course of roentgen therapy for fibroids. As we were unaware of the likelihood of sigmoid stricture in her case, no investigation was made, and the attacks were believed due to indiscretions in diet plus hemorrhoids. Finally an unusually severe attack of obstipation and pain occurred, barium enema examination was done (Fig. 7), and the patient was operated upon. Ten centimeters of intestine, including the proximal narrowing seen on the roentgenogram, was resected with end-to-end anastomosis, and a temporary colostomy done, which was closed ten

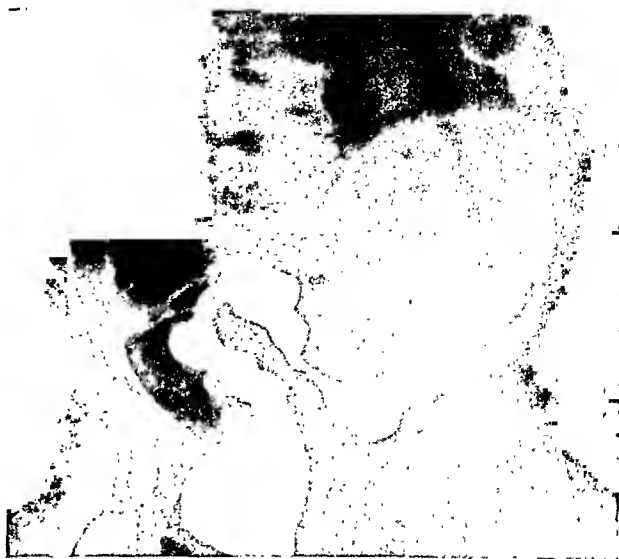


FIG. 7. Case v. Note narrowings in mid-sigmoid and distal sigmoid. Actual condition unrecognized for over five years after irradiation, though bowel symptoms had occurred intermittently throughout this period. This whole segment of intestine found at operation to be enmeshed in dense pelvic adhesions. Resection of 10 cm. of bowel including the proximal stricture was done, with end-to-end anastomosis, and a good functional result obtained immediately. Distal narrowing not identified at operation and gave trouble one year later when bowel disturbance recurred.

days later. The wall of the intestine was  $1\frac{1}{2}$  inches thick at its most constricted part, densely adherent to the uterine fundus and left adnexa, and perforated at its point of attachment. Generalized pelvic fibrosis was present. The affected bowel showed the whitish, rubber tube appearance characteristic of these fibrotic, ischemic lesions. The bowels moved well almost immediately after operation, and the patient had no further difficulty for over a year, when she again complained of severe constipation, and a proctoscopic examination was done. The instrument could not be passed more than 5 inches, where the bowel was narrowed and edematous, but no ulceration was seen. The diagnosis was stricture at the rectosigmoid, and it was assumed that the second narrowing had not been found at operation because of dense adhesions, and that the distal point of excision ran through the section of relatively normal bowel lying between two strictures. Treatment of the lower stricture was proposed, but about this time the patient developed extensive remote metastases in lungs, bone and spinal cord, and died shortly after. At autopsy no malignant disease was found in the pelvis.





FIG. 8. Case VI. Colon filled with ingested barium. Not a barium enema. Note narrow stricture of mid-sigmoid, plus ragged outline of distal sigmoid and rectum corresponding to multiple rectal ulcers. (Blebs of gas also present but irrelevant.) The upper stricture caused the immediate obstructive symptoms, precipitated by the weight of barium above the narrowing, but the patient eventually died of hemorrhage from the rectal ulcers.

Her death occurred eight years after the diagnosis and treatment of the pelvic malignancy, and about a year and a half after operation.

#### *Miscellaneous Cases*

CASE VI. W. A. This case is reported briefly to show the most extensive damage we have encountered, and to emphasize a caution in the handling of post-irradiation diarrheas. Symptoms appeared five months after radium treatment, three months after the end of roentgen irradiation, and consisted of severe griping pain, bright red blood, and fifteen to twenty stools a day. She was given by her home physician 2 ounces of barium sulfate daily, apparently to lessen the intestinal irritability. After five or six days of this she was brought to the Woman's Hospital with obstipation and great pain, and the bowel condition shown in Figure 8. This is not a barium enema, but an accumulation of ingested barium in the colon above the stricture, and the weight and bulk

of the barium evidently served to precipitate a high degree of obstruction. Proctoscopy showed constriction 13 cm. from the anus. There was edema of the mucous membrane. Ulcers about 1 cm. in diameter were scattered at various points on the rectal wall, and ulcer patches could be seen above the constriction. A colostomy was performed and the patient did fairly well for a while, but the ulcers did not heal and she died of secondary hemorrhage thirty-four days after operation.

It is obvious that such a mass of barium should never be given by mouth in the presence of low stricture. It is a good principle to avoid any oral medication that could do harm, either bulky material like this, which tends also to dry out in the distal colon, or irritating substances like cathartics, until the nature of the condition is ascertained. As to treatment, this is one of the very rare cases in which permanent colostomy plus abdominoperineal resection might have saved the patient, as the procedure done was no guarantee against the eventual fatal hemorrhage.

CASE VII. D. W. This case is an example of healing of damaged bowel by diverting the fecal stream by colostomy for a period of a year, after which the colostomy was closed and the distal segment allowed to function. The patient was irradiated in May and June, 1937, and developed an acute episode of severe pain, diarrhea and rectal bleeding six months later. In a barium enema examination, not shown here, two narrowings, in the proximal sigmoid and at the rectosigmoid junction, were found. She was treated by bland diet, belladonna and bed rest, with good results. One and a half years later, two years after irradiation, she had another upset, with obstructive symptoms (Fig. 9A). The recurrence of symptoms after so long a time suggested severely damaged intestine. Operation was decided upon and a Mikulicz colostomy was done. Many pelvic adhesions were present. The lower 4 inches of the sigmoid and part of the rectum showed white, scarred areas with telangiectatic spots, but not the wide damage seen, for example, in Case V. There were no enlarged lymph nodes, no evidence of metastasis. The colostomy functioned well and was closed after one year (Fig. 9B). She was followed for two years more, five years in all. She remained in good health, free from cancer, and with no further bowel distress. She has recently moved to Trinidad, from where she reports by letter.





FIG. 9. Case VII. *A*, two years after irradiation. (An earlier barium enema examination described in text.) Although the two strictures seen are not very narrow, there were symptoms suggestive of partial obstruction. As the patient had had a similar severe episode one and a half years before, the state of nutrition of the involved intestine and the extent of the actual damage were considered too uncertain to risk a further waiting policy, and exploratory laparotomy and colostomy were done. *B*, one year later, following closure of colostomy. There are still points of indentation (limited scarring) at the sites of the former strictures, but oblique views under the fluoroscope demonstrate a good degree of flexibility. Note pouching in the descending colon at the point where the colostomy was closed.

#### *Maximum Narrowing Without Symptoms*

CASE VIII. S. M. This case shows how narrow a stricture may exist with relatively normal bowel function. This patient was irradiated in April and May, 1939, and began to have intestinal symptoms six months later, these continuing for about a year and a half. A series of proctoscopies showed characteristic findings, at first edema of the anterior rectal wall, which bled to touch, and later induration only with mucosa friable. She received medical treatment continuously during the period of disturbance, and has been followed in the proctoscopic clinic up to the present. A barium enema examination was made in March, 1943 (Fig. 10) when she had been symptomless for over a year. She has been clinically free of cancer for nearly five

years. It seems remarkable that anything can go through such a narrow stricture.



FIG. 10. Case VIII. This barium enema examination was made four years after irradiation. Patient has had no intestinal complaints for over a year and actually has normal bowel function. Diverticula seen in sigmoid. This is our case of narrowest symptomless stricture.

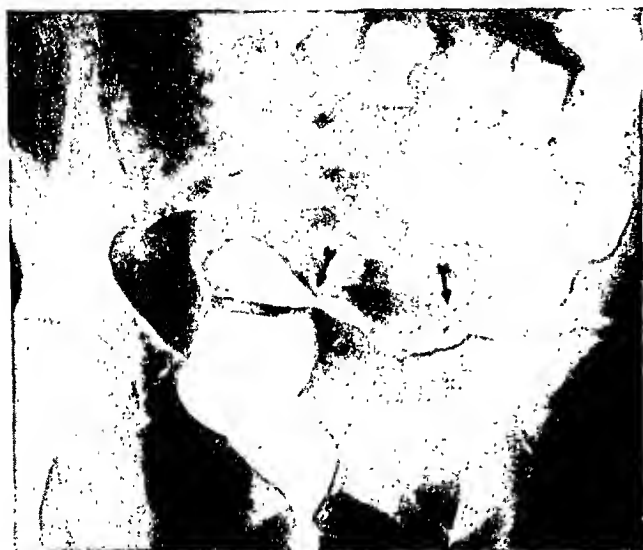


FIG. 11. Case IX. Barium enema examination made in October, 1942. The radium responsible for the stricture was given in 1923, 1924, 1925. No roentgen therapy. The patient was symptomless during most of this long interval.

#### *Stricture Discovered Twenty Years After First Irradiation*

CASE XI. S. C. Patient was first irradiated for cervical cancer in 1923, and several times in the next two years radium needles were used for small recurrences. Although she had rectal pain and bleeding in July and October, 1924, no examination of the bowel was made and apparently little attention was paid to the complaint then or later. A view of her long follow-up history shows an attack of cramps, vomiting and lower abdominal pain in 1938, a bout of constipation in 1939, and a short spell of rectal bleeding in 1941. It appears likely that earlier episodes were not recorded. She came finally to the gastroenterological clinic in 1942 for abdominal discomfort and distention after eating. A barium enema examination (Fig. 11) shows a strip of narrowing about 6 cm. long in the proximal and mid-sigmoid. Proctoscopic examination showed telangiectasis of the anterior rectal wall. The instrument could not be passed high enough to reach the stricture. The patient was treated by sedatives and attention to diet, and symptoms abated. In a second barium enema examination made five months later with the patient symptomless, the stricture remained unchanged. We are uncertain whether it had anything to do with the indigestion reported five months before. As we have no earlier enema studies it is impossible to know the age of the stricture, but it seems reasonable to date it from her first reported intestinal upset in 1924.

#### CONCLUSIONS

1. Post-irradiation proctosigmoiditis with stricture is a not uncommon cause of recurrent bowel symptoms after treatment for cancer of the cervix uteri.
2. Such symptoms are rarely due to neoplastic extension, and should be considered a post-irradiation effect until proved otherwise.
3. Severe and extensive post-irradiation damage of the bowel may and often does undergo healing with very little functional impairment, though marked anatomic defect may be present.
4. Such a favorable outcome is materially assisted by careful medical treatment.
5. Surgery should be used only after a critical study of the case, and for definite indications which should be satisfied by the operative procedure selected.

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# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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*Representatives on American Board of Radiology:* Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

*Twenty-eighth Annual Meeting:* 1944, to be announced.

## E D I T O R I A L

## ABDOMINAL ANEURYSMS

THE importance of abdominal aneurysms as the cause of abdominal pain is not too generally appreciated. The predominant complaint in patients suffering from abdominal aneurysm is pain, which may be sudden and which occurs usually in the left side of the epigastrium, no doubt due to the fact that the greatest number of abdominal aneurysms are found in the upper third of the abdominal aorta. The pain is usually of a progressive nature and increases in severity with the progress of the disease. The pain radiates to the back in the region of the upper lumbar spine and may be associated with a shooting radiating type of pain to the left buttock, left lower quadrant region and occasionally to the entire left extremity, simulating a sciatic neuritis. The pain has been variously described as boring or pounding, and patients have often been able to obtain relief by changing from a supine to a prone position. One peculiarity of the pain is that it is unassociated with the intake of food, though gastrointestinal symptoms may often be complained of when the stomach, duodenum and colon adjacent to the aneurysm become involved by pressure. In so-called silent areas aneurysms may attain considerable size and remain asymptomatic, while in other, more critical sites, severe manifestations appear early and the symptoms which arise in the gastrointestinal, genitourinary or biliary tracts are usually the result of pressure or rupture of the aneurysm.

Quite recently Scott,<sup>1</sup> in a report of 96 cases of abdominal aneurysms, has called attention to the fact that the rôle of syphilis

in the etiology of aneurysms of the thoracic aorta has been repeatedly and conclusively demonstrated, whereas aneurysms of the abdominal aorta have been less thoroughly studied. In most previous reports aneurysms occurring in each of the various abdominal arteries, namely the aortic, hepatic, splenic, etc., have usually been considered in separate communications and under these circumstances attention has not been directed toward similar and dissimilar features of the group as a whole. He points out that with the possible exception of aneurysms of the renal artery, syphilis, arteriosclerosis and bacterial agents are the important etiological factors. In the renal artery most observers agree that trauma is the most important cause. In the abdominal aorta the majority of syphilitic aneurysms arise from the proximal portion, above the origin of the renal arteries, and from branches in its upper portion, namely, the celiac axis and the superior mesenteric artery, and when syphilitic aneurysms occur in these branches, they almost invariably arise at or near their point of origin. Arteriosclerotic aneurysms arise in the distal portion of the abdominal aorta below its bifurcation or in the distal portion of the splenic artery. Mycotic aneurysms are rare in the abdominal aorta itself but are common and fairly equally distributed among its branches.

Scott points out that a fairly sharp delineation exists between the patients with syphilitic and arteriosclerotic aneurysms in his group of cases by age alone. Seventy-five per cent of the syphilitic aneurysms in his cases occurred in patients under the age of fifty, whereas all of the arteriosclerotic aneurysms occurred after this age. No

<sup>1</sup> Scott, Virgil. Abdominal aneurysms. *Am. J. Syph., Gonorr. & Ven. Dis.*, Nov., 1944, 28, 682-710.

syphilitic aneurysms were observed after the age of seventy.

The relatively high percentage of mycotic aneurysms in the younger age groups is related to the incidence of subacute bacterial endocarditis.

Hubeny and Pollack<sup>2</sup> point out the importance of syphilis in the etiology of aneurysm occurring in patients under the age of sixty and they call attention to arteriosclerosis in the older age groups, and most writers have agreed that arteriosclerosis is the major cause of aneurysms in elderly patients.

The variability of the signs and symptoms of abdominal aneurysm is dependent upon the site of the aneurysm itself and the involved adjacent structures.

Roentgenologic studies may be of con-

siderable importance in determining the presence of abdominal aneurysm. The classical sign of erosion of the vertebral column resulting from pressure of the aneurysm is a well known sign, but that calcium deposits in the wall of the aneurysmal mass may be demonstrated by roentgen study is not too generally appreciated. The demonstration of the calcium plaques by lateral and oblique roentgen studies of the abdomen in severe unexplained abdominal pain may be of considerable diagnostic aid and such a study should not be neglected. The severe pain associated with abdominal aneurysm simulates in many cases the syndrome of rupture of an abdominal hollow viscus, and when the roentgen signs are absent in these suspected cases of ruptured hollow viscera the presence of an abdominal aneurysm should be considered and roentgenological studies made with this in mind.

<sup>2</sup> Hubeny, M. J., and Pollack, S. Saccular abdominal aortic aneurysm. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 43, 385-393.



# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer.*

## MEETINGS OF ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary*, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Sept. 18-21, 1945.

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary*, Mac F. Cahal, 540 N. Michigan Ave., Chicago.

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary*, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio.

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary*, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1945, to be announced.

#### RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

*Secretary*, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

#### SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

*Secretary*, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.

#### RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

*Secretary*, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

#### SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

*Secretary*, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

#### RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION

*Secretary*, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

#### RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

*Secretary*, Dr. Roy G. Giles, Temple, Texas.

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary*, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N. Y. Meets monthly on fourth Tuesday, October to April.

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

#### CHICAGO ROENTGEN SOCIETY

*Secretary*, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary*, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary*, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.

#### DENVER RADIOLOGICAL CLUB

*Secretary*, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary*, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

#### FLORIDA RADIOLOGICAL SOCIETY

*Acting Secretary*, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary*, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

#### INDIANA ROENTGEN SOCIETY

*Secretary*, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meets annually second Sunday in May.

#### IOWA X-RAY CLUB

*Secretary*, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary*, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary*, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

#### NEBRASKA RADIOLOGICAL SOCIETY

*Secretary*, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

#### NEW ENGLAND ROENTGEN RAY SOCIETY

*Secretary*, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

#### RADIOLOGICAL SOCIETY OF NEW JERSEY

*Secretary*, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually, at time and place of State Medical Society. Mid-year meetings at place chosen by president.

#### NEW YORK ROENTGEN SOCIETY

*Secretary*, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

#### NORTH CAROLINA ROENTGEN RAY SOCIETY

*Secretary*, Dr. Major Fleming, Rocky Mount, N. C. An-

\* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

annual meeting at time and place of State Medical Society.  
Mid-year scientific meeting at place designated.

#### NORTH DAKOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. L. A. Nash, St. John's Hospital, Fargo.  
Meetings held by announcement.

#### CENTRAL NEW YORK ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse.  
Three meetings a year. January, May, November.

#### OHIO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

#### PACIFIC ROENTGEN SOCIETY

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

#### PENNSYLVANIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. L. E. Wurster, 416 Pine St., Williamsport.

#### PHILADELPHIA ROENTGEN RAY SOCIETY

*Secretary*, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

#### PITTSBURGH ROENTGEN SOCIETY

*Secretary*, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

#### ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

#### ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

*Secretary* Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

#### ST. LOUIS SOCIETY OF RADIOLOGISTS

*Secretary*, Dr. E. W. Spinzig, 2646 Potomac, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

#### SAN DIEGO ROENTGEN SOCIETY

*Secretary*, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

#### SAN FRANCISCO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Martha Mottram, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Toland Hall, University of California Hospital, second six months at Lane Hall, Stanford University Hospital.

#### SHREVEPORT RADIOLOGICAL CLUB

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

#### SOUTH CAROLINA X-RAY SOCIETY

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

#### TENNESSEE RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

#### TEXAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, Jan. 17, 1945.

#### UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

#### UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

#### VIRGINIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

#### WASHINGTON STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

#### X-RAY STUDY CLUB OF SAN FRANCISCO

*Secretary*, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

#### CUBA

#### SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

#### BRITISH EMPIRE

#### BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

#### SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

#### FACULTY OF RADIOLOGISTS

*Secretary*, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

#### SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

#### RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

#### CANADIAN ASSOCIATION OF RADIOLOGISTS

*Secretary*, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton, Alberta.

#### SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

#### RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

#### SOUTH AMERICA

#### SOCIEDAD ARGENTINA DE RADIOLOGIA

*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

#### CONTINENTAL EUROPE

#### SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

#### SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

*Secretary* for French language, Dr. A. Grosjean La Chaux de Fonds.

*Secretary* for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

#### SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

*Secretary*, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

#### ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

#### LENINGRAD ROENTGEN RAY SOCIETY

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

#### MOSCOW ROENTGEN RAY SOCIETY

*Secretaries*, Drs. L. L. Holst, A. W. Ssamycin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

#### SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.



## THE IMPORTANCE OF HISTORICAL REFRESHMENT

TO THE EDITOR:

The "refresher course" has long since become a distinct contribution to the educational value of our annual meetings. By this means we are enabled to correlate the established fundamentals of our past radiologic education with the expanding requirements of modern practice. This necessary adaptation may be materially furthered by occasional survey of the hard-won accomplishments of our vanguard pioneers.

In the October number of *THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY* there appears "A Historical Note on Roentgenologic Literature" from the pen of our recent President, Dr. Sherwood Moore. In this communication he writes especially of *The American X-ray Journal*, that literary forerunner of our present thriving Journal, and of Dr. Heber Robarts, its Editor and the first President of the American Roentgen Ray Society. Dr. Moore observes that "... many, if not most, radiologists are unaware of the existence of this publication important in its

day." True words indeed, but nevertheless a sad commentary on the efforts of more than one historian who has striven to revive the memory of these fast-fading figures of Radiology's heroic Past. The resultant records lie freely open within our libraries for all to see, and Dr. Moore does well to take official note of the degree of general ignorance that can be engendered only by unthinking disregard of them.

Such of these records, and they are by no means meagre, as apply to the career of Heber Robarts, reveal not only the vicissitudes of the pioneer, but also the physical distresses of the true martyr to Science through the effect of radiation damage. For him, the advent of death was inevitable as the result of his devotion to radium therapy, but his constitutional strength grievously extended his years of suffering.

The quality of self-sacrifice, as manifested by the lives of Robarts and those like him, is inseparable from that revealed in conflict under our Flag. To contemplate such lives, even in tardy review, is good for the soul.

PERCY BROWN



## DEPARTMENT OF TECHNIQUE

*Department Editor:* ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.  
Charleston, S. C.

### A NEW ANTEROPOSTERIOR PROJECTION FOR ROENTGENOGRAPHY OF THE OPTIC FORAMEN

By SIDNEY ALEXANDER, R.T.

*From the Department of Internal Medicine, New York State Psychiatric Institute and Hospital  
NEW YORK, NEW YORK*

A REVIEW of the literature for the past fifteen years reveals a number of methods for roentgenographing the optic foramen, all of which utilize the posteroanterior position. In the Rhese method,<sup>8</sup> the head is placed in the forehead-nose position and then rotated obliquely to either side, the chin being in contact with the cassette or table top. The central ray passes through a point  $2\frac{1}{2}$  inches above and behind the opposite external auditory canal, directly through the orbit near the film. Pfeiffer<sup>13</sup> objects to this method of projecting the ethmoid sinuses through the margin of the orbit, as a hit and miss affair. He describes his own "V" tunnel apparatus that produces good results without changing the original position of the head. Instead of rotating the head, the tube is moved from side to side, and the cassette is changed from one side of the tunnel to the other.

The MacMillian special position is similar to the Rhese position, except that a  $15^\circ$  angle board is used and the central ray is projected vertically so that it passes through the head from the opposite occipital region and emerges at the orbit. This technique is simplified by the use of a Camp<sup>2</sup> localizer. Epstein and Kulick<sup>4</sup> and Wittenberg<sup>18</sup> describe a simple adaptation of the Bullitt mastoid apparatus for roentgenographing the optic foramen. More recently, Epstein and Kulick<sup>5</sup> presented a method in which the use of mechanical devices for positioning the head are dispensed with. The

method is similar to the MacMillian position, the patient being prone with the malar eminence, tip of nose, and the superior orbital ridge touching the cassette. However,

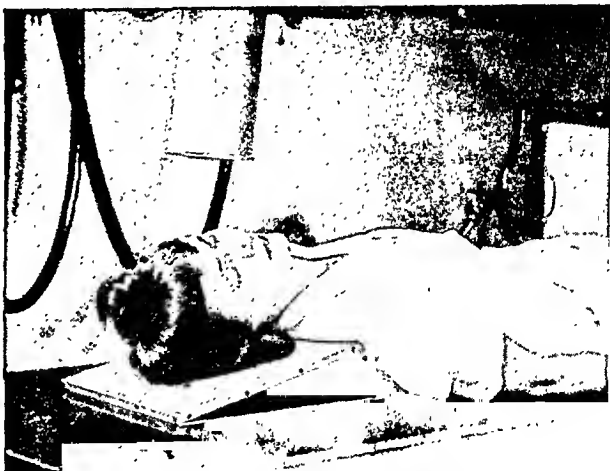


FIG. 1. The anteroposterior position for the optic foramen, including the use of a  $40^\circ$  cardboard triangle.

they suggest elevating the superior orbital ridge 1 inch, by means of a wedge of felt, to prevent foreshortening of the optic foramen in the longitudinal axis. Instead of the horizontal position, a  $15^\circ$  angle board may be used, similar to that prescribed in the MacMillian position.

A study was carried out using the anteroposterior position for roentgenographing

skull makes a  $40^\circ$  angle with the horizontal table. The tube is centered so that the central ray is perpendicular to the horizontal table and passes through the orbit which is being roentgenographed (Fig. 1). Technical factors are as follows: small focal spot, anode film distance 30 inches, 55 kv. and 15 ma., at  $\frac{1}{2}$  second with a small extension cone.

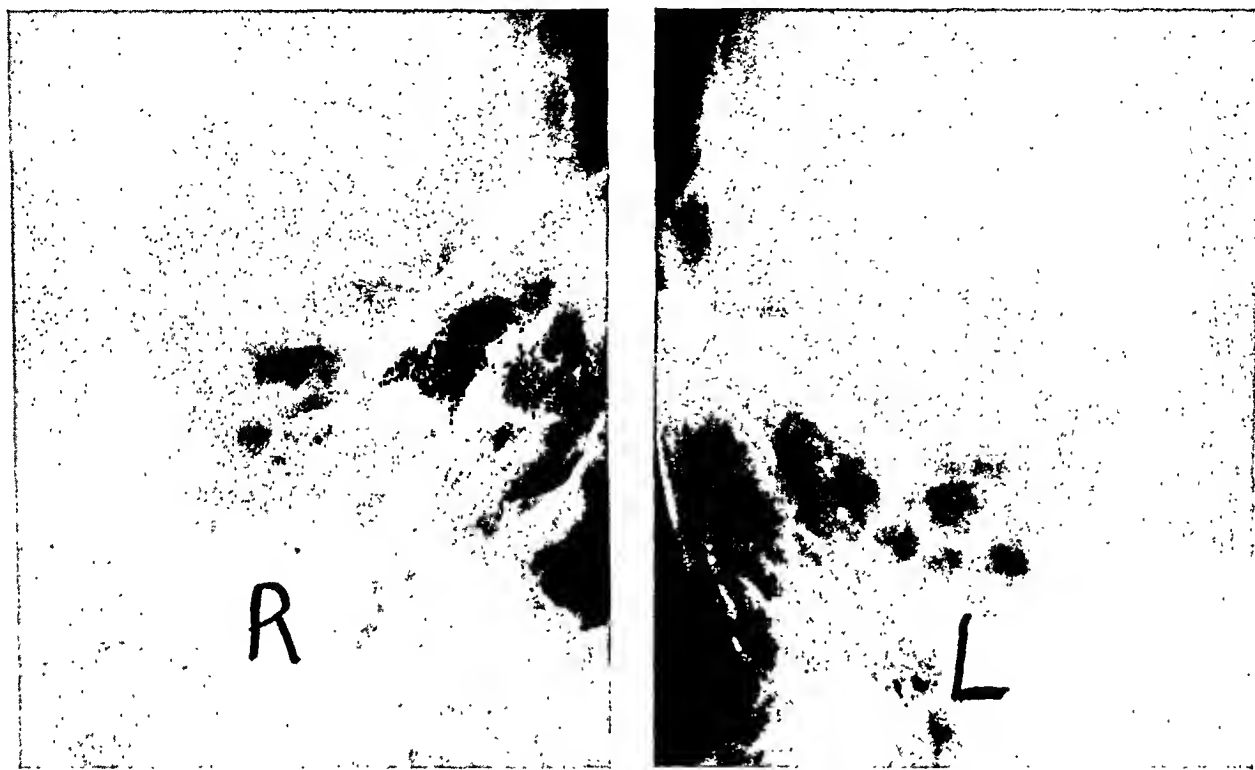


FIG. 2. An anteroposterior projection of both foramina.

the optic foramen, the results of which are recorded in this paper.

#### PROCEDURE

The patient is supine. An angle board of  $15^\circ$  reversed is used and the patient lies with his head extended overhanging the angle board. The head is rotated  $40^\circ$ , either to the left or right, depending upon the optic foramen to be projected, i.e., left for the right foramen and right for the left. The proper rotation is obtained by means of a cardboard triangle with a  $40^\circ$  angle. This triangle is placed on the horizontal table in back of the skull, and the head is rotated until the mid-anteroposterior line of the

#### DISCUSSION

Various other anteroposterior positions were tried before the final procedure was adopted. With the skull placed horizontally and rotated from  $10^\circ$  to  $80^\circ$  in either direction, it was ascertained that the optic foramen could be visualized at  $30^\circ$  and  $35^\circ$ . However, the projections were not satisfactory since the shadow of the mastoid and sinuses overlapped that of the optic foramen. With a  $35^\circ$  rotation the foramen fell within the orbit while at  $30^\circ$  it was outside. It was noted, too, that the head had to be rotated in the opposite direction of the foramen to be roentgenographed, i.e., to the left when the right foramen is desired, and vice



FIG. 3. A posteroanterior projection (MacMillan position) of the optic foramen of the same patient for comparison.

versa. Angle boards from  $5^{\circ}$  to  $25^{\circ}$ , placed so as to flex the head, were tried. The most satisfactory results were obtained with an angle board of  $15^{\circ}$  and a  $40^{\circ}$  rotation of the head. There was still, however, some overlapping shadows with noticeable enlargement of the foramen as compared with the posteroanterior MacMillian position. A  $5^{\circ}$  tilt, both toward the nose and toward the occipital region, produced no changes.

The final step is that described in the procedure of this paper. This anteroposterior projection compares favorably with the procedures in which the posteroanterior position is employed. It is a simple procedure as far as both the technician and patient are concerned. It involves no costly or additional equipment. A view of the foramen is obtained clear of the mastoid and sinuses (Fig. 2). Although a detailed comparison of both the anteroposterior and posteroanterior methods, by actual measurements of the optic foramen, has not been attempted

at this time, in general the foramina appear very similar by both methods (Fig. 3). The procedure is not only simple and easily carried out by the roentgen technician, but it is also much easier for the patient, both adults and children. The results obtained compare satisfactorily with those obtained by the older methods.

## SUMMARY

1. A method using the anteroposterior position for roentgenographing the optic foramen is presented.
2. The method is simple and easy for both technician and patient.
3. The results can be duplicated and are as satisfactory as those obtained by the posteroanterior methods in use at present.

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